POWER

Volume 62 New York, December 29, 1925 *No.* 26

A Happy New Year

Ring out wild bells to the wild sky,
The flying cloud, the frosty light.
The year is dying in the night;
Ring out, wild bells, and let him die.

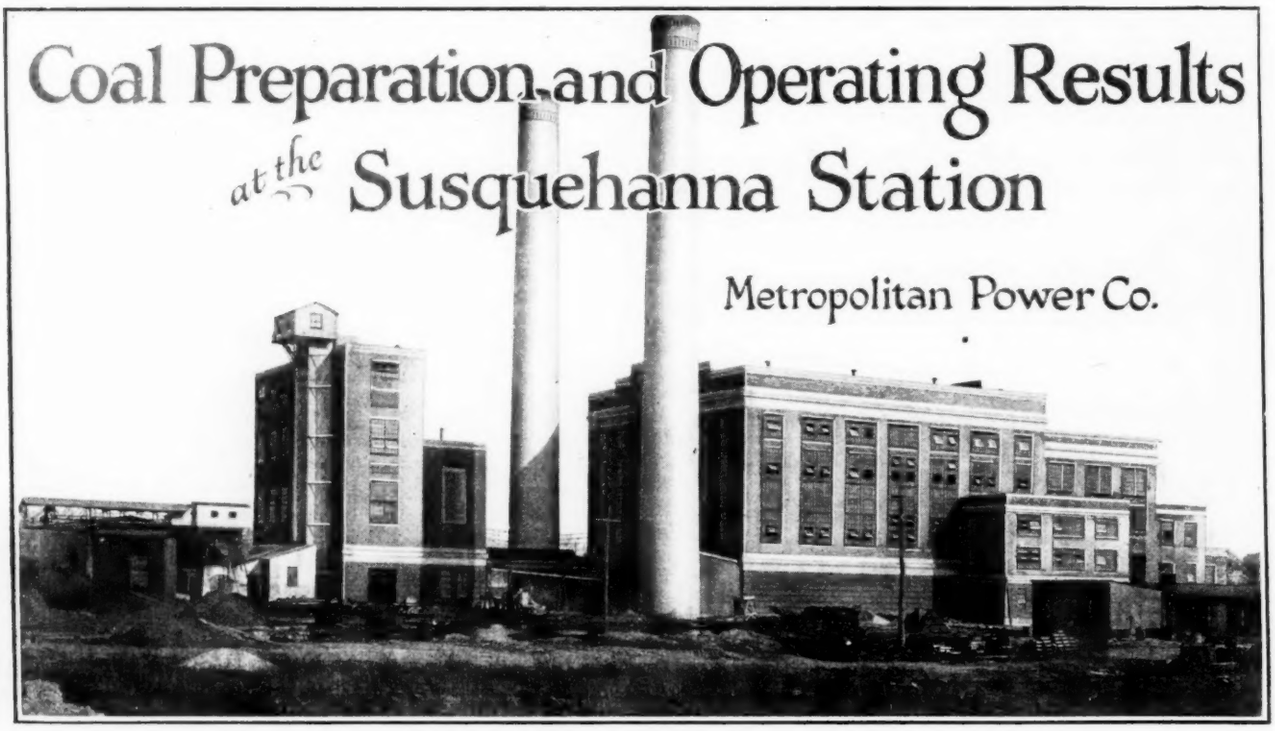
* * * *

Ring out the old, ring in the new.
Ring out the false, ring in the true.
In Memoriam.

MAY the year which is to come bring to you one and all an abundant measure of happiness and success.

F. R. Low

Coal Preparation and Operating Results at the Susquehanna Station



Plant designed for 200,000 kilowatts ultimate capacity. Pulverized bituminous and river coal used as fuel. Combined waste heat and steam drier employed. Tests of boiler plant show over 90 per cent efficiency

EARLY in 1923, realizing that the practical limit of capacity of its two major stations at Reading and Easton would soon be reached and that the growth of load would demand a large increase in generating capacity, the Metropolitan Edison Company, a subsidiary of the General Gas & Electric Corporation, laid plans for two base-load stations, one to be built at Middletown, Pa., on the Susquehanna River, about 12 miles southeast of Harrisburg, and one at Holland, Pa., on the Delaware River near Easton.

As the site at Middletown was more nearly the center of load demand and additional capacity was badly needed in that section, the Holland project was suspended temporarily and construction of the Middletown plant rushed as rapidly as possible.

The system of which this station forms an important part is what is known as the Pennsylvania-New Jersey Power System, which stretches from Gettysburg, Pa., on the west to Boonton, N. J., on the east, and supplies most of the intervening territory, including the cities of Harrisburg, Reading, Easton, Lebanon and York, Pa. This system constitutes a portion of the superpower system proposed for the North Atlantic States.

In a preliminary article[1] the important details and engineering features of this station were outlined and the reasons for selecting certain types of equipment were stated. It will therefore not be necessary to touch upon these again at this time, further reference being made here to the coal-preparation plant, which is probably one of the most complete installations yet made.

The original plans called for a station having an ultimate capacity of 200,000 kw., to be built in three sections. The first section has been designed to accommodate two 30,000-kw. turbo-generator units and six 15,000-sq.ft. boilers with their complement of auxiliaries, one generating unit and four boilers now being in service. The installation of the second 35,000-kw. unit is now under way.

The outstanding factors that dictated the adoption of pulverized fuel as the method of firing the boilers were its ability to burn practically any grade of coal, flexibility of operation, including quick pick-up of load and elimination of banking losses. It was also realized that by going to pulverized fuel, the various grades of bituminous coals commercially available, as well as the large quantities of river coal that could be obtained from the river bed adjacent to the plant site, could be efficiently utilized and in addition would make the plant independent of any one source of supply.

As no published data were available as to the relative efficiencies of the different types of pulverizing mills, it was decided to install three different types and thus obtain some first-hand information on the best method of pulverizing the various grades of coal and also the cost for power and maintenance per ton of coal pulverized. Five pulverizers comprise the initial mill installation, one of these being a conical ball mill of six tons per hour capacity, and four ring-roll mills of two different types.

Referring to the plot plan, Fig. 8, the general arrangement of the preparation plant and raw-coal handling equipment in relation to the boiler plant is indicated. The building is of structural steel with red

[1] *Power*, Dec. 25, 1923.

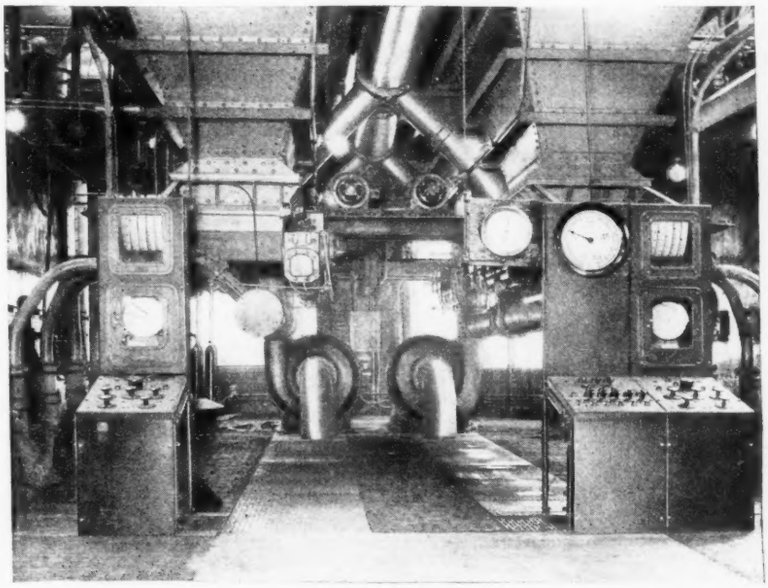


Fig. 1—Arrangement of feeders, primary air fans and instrument panels

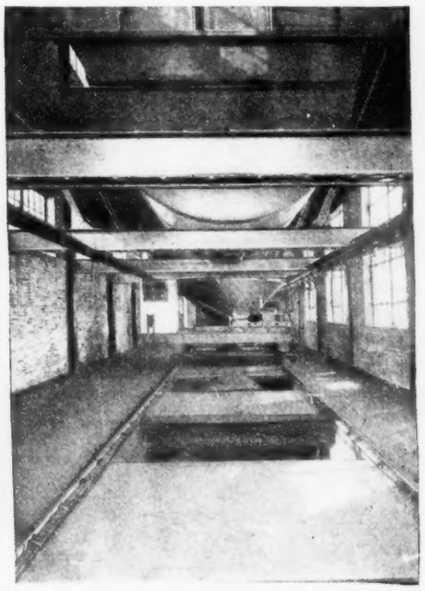


Fig. 2—Coal-weighing larry

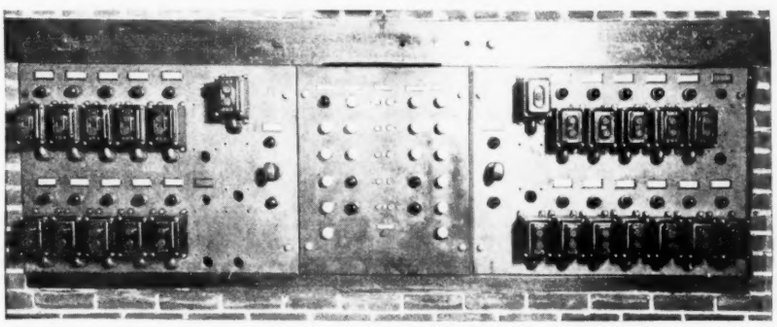


Fig. 3—Push-button-control and bin-signal panels in preparation plant

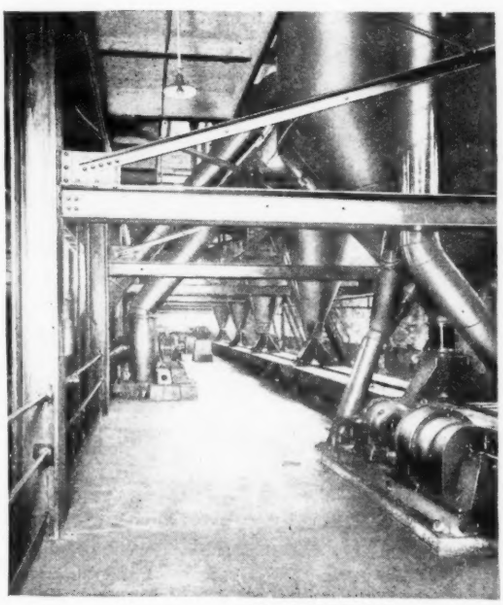


Fig. 4—Exhausters and screw conveyors

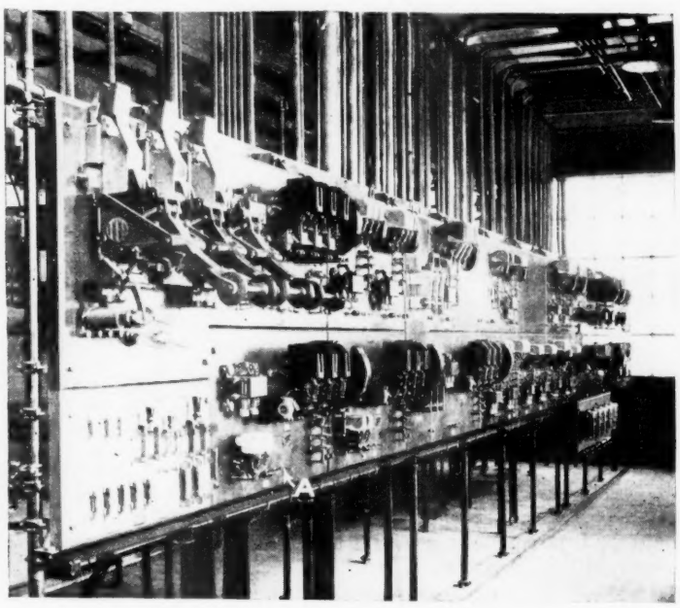


Fig. 5—Main control board for coal-preparation equipment

brick walls, to harmonize with the main station building.

The bituminous coal is received by rail and delivered over track hoppers from which it is carried by short apron feeders to an inclined apron conveyor and discharged directly to a rotary breaker or to a shuttle conveyor, the latter being used when storing the coal. In passing through the breaker the coal is reduced to 1¼ in. or under, suitable for passing to the pulverizers. No auxiliary crusher is used. From the breaker the coal is carried by a short inclined belt conveyor, the head pulley of which serves as a magnetic separator for removing the tramp iron, and delivered to a bucket elevator which conveys it to a distributing belt conveyor over the bunkers.

In one corner of the building, housing the unloading hoppers and conveyors, a small room has been partitioned off and equipped with the necessary crushing, weighing and drying apparatus for obtaining the percentage of moisture in the samples of coal obtained from the cars as received. Further analyses of the samples are made at the head office in Reading.

From the bucket elevator the coal is discharged directly to a 30-in. belt conveyor which distributes it to the bunkers. The belt is unloaded by a plow spreader equipped with a motor-driven brush to clean the belt thoroughly after passing under the plow. Independent telephone communication is provided between this floor of the preparation plant and the point of unloading the coal, to facilitate interchange of orders.

The capacity of the raw-coal handling equipment at present installed is 75 tons an hour. The various units are motor-driven and interlocked electrically for sequence starting and stopping. The push-button control board for this section of the coal-handling apparatus is located within the foundation of the rotary breaker. Thus the opportunity was taken to utilize this space and at the same time provide a dustproof location for the control conveniently situated for the starting and stopping of the different units.

The small-sized anthracite that is dredged from the river bed is at present pumped to a storage pile on the bank, then loaded into cars by locomotive crane for transporting to the unloading hoppers. It is planned to pump the coal directly into cars eventually and thus obviate the reloading. The bituminous coal is reclaimed from storage by drag scraper.

For weighing the coal a 6-ton larry is placed between the bunkers and the pulverizing mills, as shown in the cross-section, Fig. 6. The larry is equipped with a registering beam, and the tickets on which the weight is stamped are punched by the operator, to show the number of bunker to which the coal was delivered, kind of coal (river or bituminous), whether taken from storage or bunker, and the date. The weighing beam is in a cab on the side of the larry, and the gates of the coal bunker, larry hopper, as well as the controllers for the larry motor, are operated from this position.

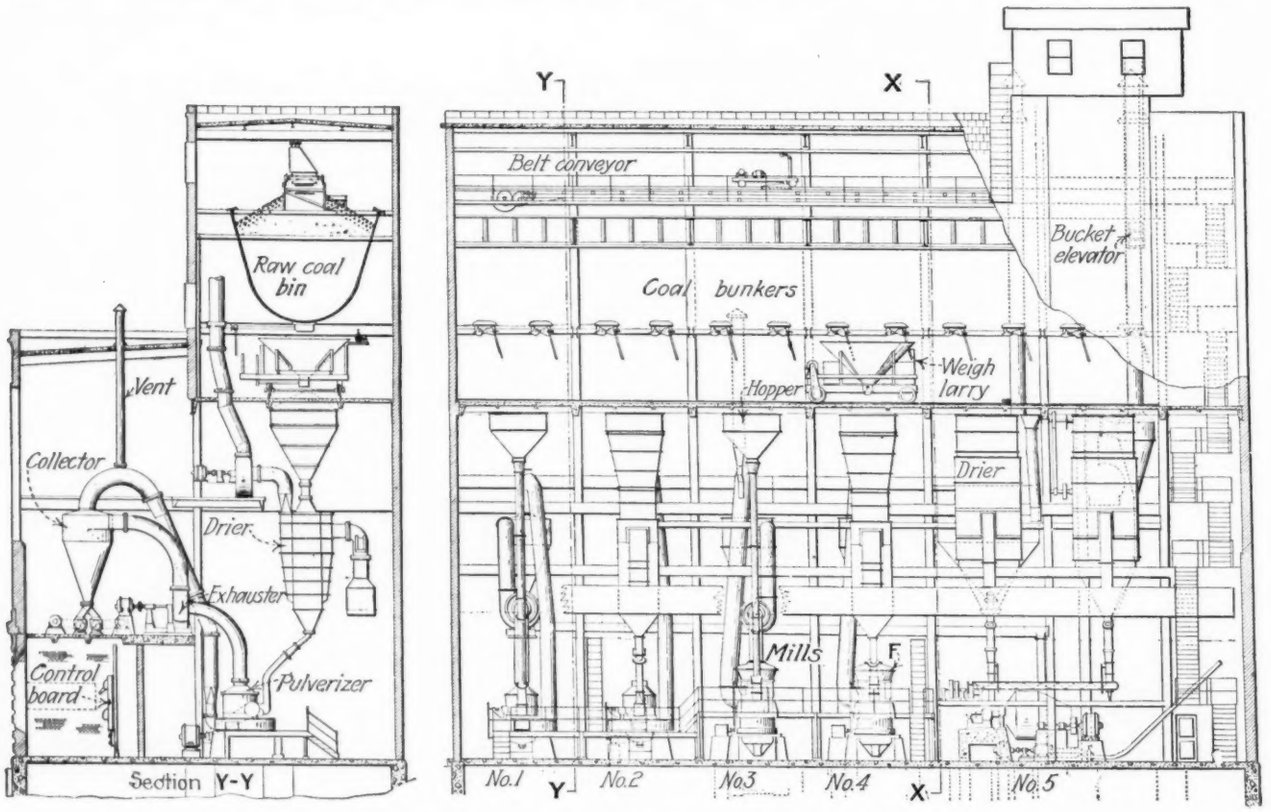


Fig. 6—Cross-section and sectional elevation of preparation plant

As the river coal contains about 11 per cent moisture as delivered to the bunker, two waste-heat driers (at the right, Fig. 6) were installed to reduce this moisture to about 3 per cent before the coal passes to the pulverizers. Owing to the fineness of this coal it was found impossible to get sufficient gas through it in the drier to lower the moisture sufficient for satisfactory grinding. This difficulty was overcome by installing low-pressure steam elements or grids in the drier to supplement the waste heat. The exhaust steam at about 2 lb. pressure used in these elements is brought from the plant through

an 8-in. header from which individual connections are made to each section of elements. The sections are also connected separately to a 4-in. return line on which a vacuum of 8 to 10 in. is maintained by a return pump under automatic control. Combined waste-heat

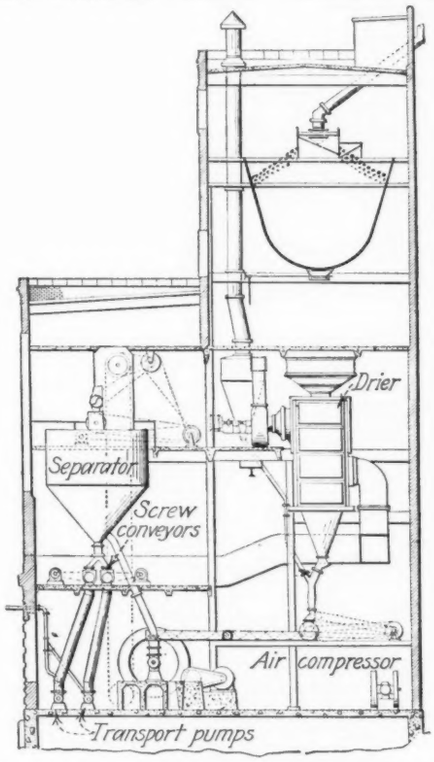


Fig. 7—Cross-section of preparation plant showing arrangement of ball mill, conveyors and transport pumps

This unit is now being changed to air separation

and steam driers are also installed over Nos. 2 and 4 mills to take care of the bituminous coal that may be received too wet for pulverization.

TABLE I—SUMMARY OF TEST RESULTS

Duration of test, hours	72.167	22.517
Power generated, kw.-hr.	1,932,294	499,096
Power output, kw.-hr.	1,815,861	467,506
Power to auxiliaries, kw.-hr.	116,884	32,488
Power to coal house, kw.-hr.	14,715	3,630
Coal consumed, lb.	2,016,292	524,115
Total water evaporated, lb	22,658,753	5,820,090
Average kw.-hr. generated	26,790	22,200
Average kw.-hr. output	25,150	20,800
Volts—generator leads	13,800	13,820
Current per phase, amperes	1,220	1,060
Average power factor, per cent (computed)	91.9	78.5
B.t.u. per lb. coal	14,324	14,385
Deviation from specified vacuum, pressure and superheat in turbine guarantee, per cent	—8.9	—7.8
Results as Recorded by Test		
Coal per kw.-hr. generated, lb.	1.042	1.051
Coal per kw.-hr. output, lb.	1.110	1.121
B.t.u. per kw.-hr. output	15,900	16,100
Pounds water evaporated per lb. coal	11.25	11.11
Efficiency boiler plant, per cent	89.4	92.9
Water used per kw.-hr. output, lb	12.50	12.45
Auxiliary energy to plant output, per cent	6.43	6.94
Coal house energy to plant output, per cent	0.81	0.78
Saturated to total steam, per cent	2.94	2.78
Makeup to total steam, per cent	1.10	1.22
Corrected for deviation of vacuum, pressure and superheat from turbine guarantee.		
Water per kw.-hr. output, lb.	11.40	11.49
Coal per kw.-hr. output, lb	1.013	10.32
B.t.u. per kw.-hr. output	14,510	14,850

Referring to the plot plan, Fig. 8, the gases are taken from the breeching at a point close to the stack and carried to the driers through a sheet-metal duct. The temperature at the drier runs around 250 deg. To give flexibility in the operation of the driers and to provide a somewhat higher temperature than the normal exit temperature of the furnace gases, a small separately fired furnace has been recently installed to raise the temperature of the gas to any desired point.

The gas is drawn through each drier by a motor-driven fan located on the floor directly above or adjacent

TABLE II—PRINCIPAL SIZES AND RATIOS

Total ground area covered by buildings and coal storage			60 acres
Dimension of buildings:			
Turbine room	Length, Ft.	Width, Ft.	Height, Ft.
Ultimate	540	56	60
Present	110	56	60
Boiler room			
Ultimate	540	126	80
Present	110	126	80
Area in sq.ft. per installed kilowatt:		Turbine Room	Boiler Room
Ultimate capacity		0.15	0.34
Capacity of plant			Kw.
Ultimate	(6—30,000 or 35,000-kw. units)		= 200,000
Present	(1—30,000-kw. unit)		= 30,000
Boiler capacity			
Ultimate	24—15,000 sq.ft.		= 360,000
Present	4—15,000 sq.ft.		= 60,000
Boiler-heating surface per (ultimate) kw. capacity, sq.ft.			1.8
Stack area per 1,000 sq.ft. of boiler-heating surface, sq.ft			3.5
Furnace volume, cu.ft. (above water screen)			11,000
Ratio furnace volume to water-heating surface			0.75
Pounds coal fired per cu.ft. of furnace volume per hour (at 225 per cent rating)			0.847
Superheating surface per boiler, sq.ft.			2,130
Ratio of superheating surface to boiler-heating surface			1 to 7
Economizer surface, sq.ft.			7,660 and 7,776
Ratio of economizer heating surface to boiler-heating surface			0.49 and 0.51
Condenser cooling surface, sq.ft.			45,005
Capacity steam per hour, lb			280,000
Condenser tube surface per kilowatt capacity of prime mover, sq.ft.			1.0
Cooling water per pound of steam condensed, lb.			1.9
Steam condensed per sq.ft. of tube surface, lb. per min.			6.25
Capacity of circulating pumps—per kilowatt installed, gal. per min.			2.16
Area of circulating-water intake per 1,000 gal. of water per min., sq.ft.			3.4

to the driers. As the amount of gas passing through each drier is controlled by manual operation of the damper in the gas inlet, indicating dial thermometers, to show the temperature of the gas entering the drier and the temperature of the coal leaving, are installed at this level for the guidance of the operator. These instruments are supplemented by recording thermometers installed at the lower operating floor level.

From the cyclone separators to which the coal is delivered from the mills, it passes to duplicate screw

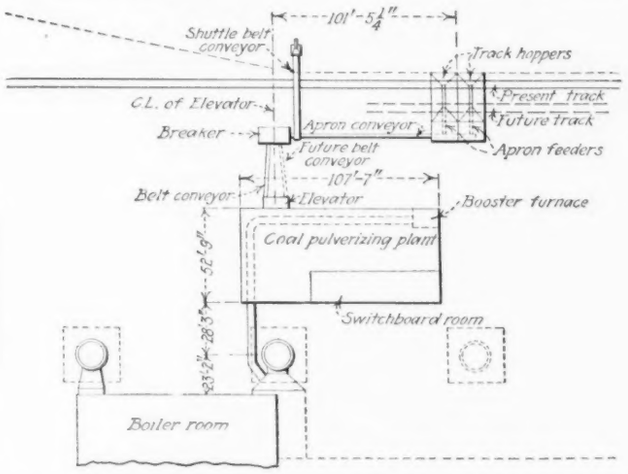


Fig. 8—Plot plan showing location of coal-preparation plant in relation to boiler room

conveyors and is carried to two transport pumps and conveyed through a 5-in. pipe line to the fuel bins above the boilers. A switching or distributing valve is inserted in the transport line a short distance from the pump, and by means of this the coal is transferred to an auxiliary line feeding the fuel bin at the auxiliary furnace previously mentioned. Additional valves are inserted in the main transport pipe in the boiler room to supply the individual bins at each boiler.

A feature of the plant is the push-button control for

starting and stopping all motors. Instead of an auto starter at each motor, as is the usual practice, the contactors are all grouped on one main control board (see Fig. 5). These contactors are in turn opened and closed by push buttons grouped on panels at convenient locations. The control panels for all motors in the preparation plant are shown in Fig. 3. The room in which this main control board is placed is sealed off dust-tight from the rest of the plant, the

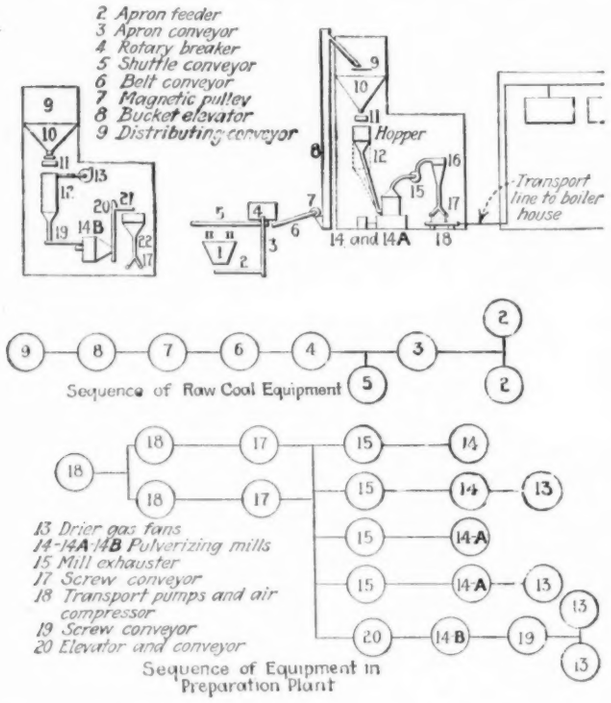


Fig. 9—Sequence of raw-coal and pulverizing equipment

only means of access to the room being through a door in the outside wall.

As previously mentioned, all motors are electrically interlocked for sequence starting and stopping; the importance of this will be apparent from a study of Fig. 9.

In the preparation plant the air compressor that furnishes the air to transport the coal to the bins in the boiler room forms the master control for the entire equipment. The stopping of this machine through an interruption in the service or by pushing the proper button on the control panel automatically shuts down the complete plant, and the interlocking feature precludes the possibility of any one machine being started until the compressor is once more in operation. With reference to the other machines in the plant, the stopping of any particular unit will affect only the units ahead of it in relation to the direction of coal flow, but not beyond. The same interlocking feature is applied to the raw-coal handling equipment, in which case the distributing conveyor is the main control.

As repairs and adjustments are required from time to time, provision has been made in the control system to permit operating any particular machine independently. This is accomplished by throwing over the single-pole double-throw switch *A* (see Fig. 5) in any particular motor panel.

The flow of pulverized coal from the pumps to the furnace bins is remotely controlled by push-button electrical connections on a switching and indicating panel, as shown in the center of the board, Fig. 3. Each fuel bin is equipped with a high- and low-level electric bin indicator which automatically shows when the material reaches a certain predetermined high or low level by extinguishing or lighting pilot lamps on the switchboard. Each distributing valve has electrical connections with pilot lamps on the same board which register the position of the valves. The valves are electropneumatically operated from the switchboard by push-button control or are automatically thrown by the electric bin indicators. Although this control system may at first appear somewhat extensive, it greatly facilitates the operation of the preparation plant, three men only being required per shift.

The initial boiler installation consists of four 14,770-sq.ft. inclined water-tube boilers, each having a 2,130-sq.ft. convection-type superheater located at the end of the first pass. A separate economizer of approximately 7,600 sq.ft. is placed directly behind each boiler and connected in the gas passage to the main

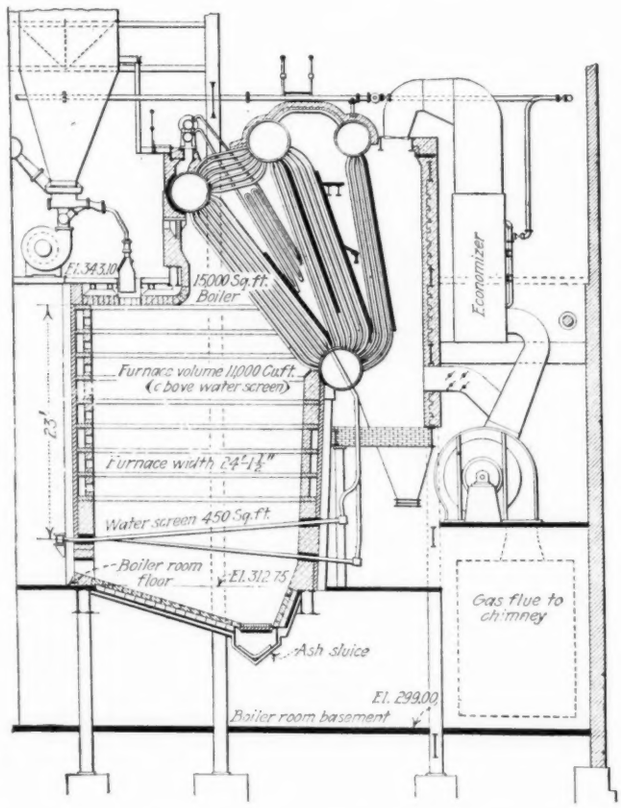


Fig. 10—Cross-section of boiler setting and furnace

flue, as shown in the cross-section, Fig. 10. Two different types of economizers are being tried out.

Although designed for 350-lb. pressure, the boilers are operated to give 325 lb. at the turbine throttle with a total temperature of 670 deg. F. They are operated normally at 225 per cent of rating. Each boiler is fired by six burners placed vertically in the arch forming the top of the combustion chamber. The feeders, one for each burner, are mounted directly below the pulverized-fuel bins and are arranged in two groups of three, each group being driven by a 7½-hp. variable-speed motor through a silent chain and drive shaft. Each feeder is connected to the driving shaft through a clutch, thus permitting all or any number of feeders

to be operated at one time. For emergency service a constant-speed motor is installed on a suitable base above the feeders. This motor is brought in to service, in the event of failure of the other drive, by disengaging one clutch and engaging another one.

The primary air, which constitutes about 35 per cent of the total required for combustion, is supplied by two motor-driven fans located on the boiler-operating floor. The fans discharge to a 24-in. header directly overhead with branches leading to a manifold below the feeders.

The boiler control boards are mounted on structural frames in the firing aisle adjacent to each boiler (see Fig. 1). Each board has a vertical panel equipped with a multi-point draft gage and steam-flow-air-flow meter, and a desk panel equipped with the control for starting and stopping, and varying the speed of the feeder motor, regulating the speed of the induced-draft fans, and for emergency closing of the boiler stop valves. A second panel at the No. 1 boiler is equipped with a load indicator and push-button control for the circuit breakers on the different motor circuits.

The boiler furnaces are designed with ample volume and capacity for burning widely varying grades of coal. The furnace volume per boiler is 11,000 cu.ft. above the water screen, giving a ratio of furnace volume to water-heating surface, including water screen, of 0.70 to 1. A cross-section of the furnace is shown in Fig. 10. They are constructed with hollow walls through which the secondary air is passed before being admitted to the furnace. A water screen built of 4-in. tubes 12 in. on centers and having an effective area of 450 sq.ft., prevents excessive furnace temperatures and slagging of ash in the furnace.

The hopper bottom of the furnace serves as an ash-pit, the ashes being discharged through air-operated gates and sluiced into a sump from which they are pumped for filling up the land surrounding the plant.

Each row of three boilers is served by a single brick stack having an internal diameter at the base of 18 ft. 2½ in. and 14 ft. at the top, giving a stack area per 1,000 sq.ft. of boiler-heating surface, of 3.5 sq.ft.

The bituminous coal that is normally used in the plant is principally slack of the following approximate analysis: Moisture, 2 per cent; volatile matter, 23 per cent; fixed carbon, 64 per cent; ash, 9 per cent; and sulphur, 2 per cent. The heat value as received is around 13,500 B.t.u. The anthracite as reclaimed from the river bed is on the average smaller than No. 3 buckwheat and has a calorific value of approximately 11,000 B.t.u.

The total station economy from coal received at the unloading hopper, over a period of six months, has been as follows:

	B.t.u. per Gross	Kw.-Hr. Net	Maximum Load, Kw.	Capacity Factor	Net Output, Kw.-Hr.
March	15,490	16,615	31,000	50.2	10,451,860
April	15,850	17,072	31,000	47.4	9,533,870
May	16,270	17,678	30,000	37.3	7,704,610
June	17,370	19,181	28,000	33.9	6,641,020
July	15,830	17,151	36,000	51.7	10,687,860
August	15,740	16,887	32,000	59.4	12,384,700

In a series of tests conducted recently on one of the steam-generating units an over-all boiler efficiency of approximately 90 per cent was obtained. The tests were made under conditions that obtain in regular practice. The coal used for the series of tests was taken from the regular source of supply and represented a good grade of bituminous averaging 14,300 B.t.u. as fired and containing an average of 6.08 per cent ash.

Taylor Connection for Transforming from Three-Phase to Two-Phase

By J. B. Gibbs*

THE Taylor transformer connection is one that is sometimes used for supplying two-phase power from a three-phase system, or vice versa. It requires three single-phase transformers or one three-phase

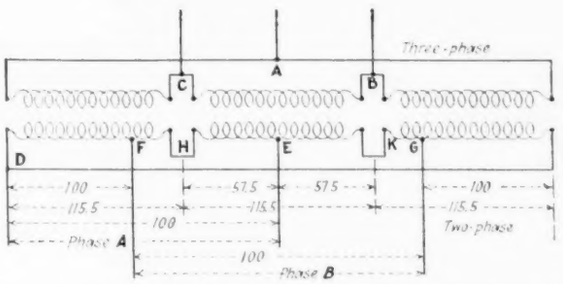


Fig. 1—Three single-phase transformers grouped for changing from three-phase to two-phase

transformer connected in delta and provided with the necessary special taps. A diagram of the connection is shown in Fig. 1, and to simplify the study of this connection the windings are shown in the form of a delta Fig. 2. These two figures show the same connection, the only difference being the arrangement on the transformers in the diagrams. The primary windings of the three transformers that are connected in delta on the three-phase side are represented by *AB*, *BC* and *CA*, and the secondary windings on the two-phase side are represented by *DK*, *KH* and *HD*, in both figures. Taps are placed in the secondaries at *F*, *E* and *G* in such a way that the voltage from *D* to *E* is at right angles to the voltage from *F* to *G* and equal to it (see Fig. 2). This is the condition for a two-phase circuit. It should be noted that the voltage *GF* does not cross the voltage line *DE* at the middle,

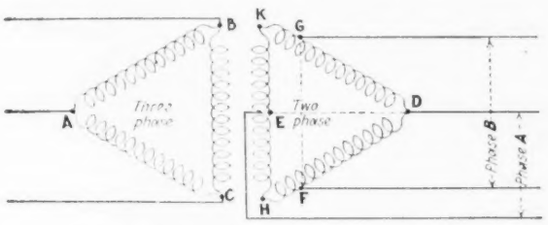


Fig. 2—Simplified diagram of Fig. 1

therefore the two-phase voltages are not symmetrical and this connection cannot be used with two-phase motors whose two windings are interconnected. In modern two-phase motors the two windings are entirely separate, so that the two-phase voltages not being symmetrical is no objection; but if old-type motors are to be used, the interconnection of the windings should be investigated.

If a voltmeter is connected from *D* to *E*, Fig. 2, it will be found that the voltage is 0.866 times that from

*Transformer engineer, Westinghouse Electric & Manufacturing Co.

H to *D*, *D* to *K*, or *K* to *H*. Therefore the taps *F* and *G* must be brought out at a point on *DF* and *DK* to give a voltage equal to 0.866 of that across the total winding if a two-phase relation is to be obtained. Assume, for convenience, that the two-phase voltage is to be equal to the primary three-phase voltage. Then the voltage obtained from *D* to *F* and *D* to *G* must equal that from *A* to *B* and *A* to *C*. But the voltage from *D* to *G* is only 0.866 that from *A* to *B*, therefore if the three-phase voltage is assumed to be 100, then the voltage across each transformer on the two-phase side will be 100 ÷ 0.866 = 115.5. Expressing this another way it can be said that the transformers on the two-phase side must have sufficient turns to give 115.5 per cent of the desired two-phase voltage.

It can also be shown that with a balanced load on the two-phase system, the current in the windings *D* to *F* and *D* to *G* is 0.866 of that from *F* to *E* and *G* to *E*. As a result of this relation of voltage and currents in the various windings the transformers have to be 11 per cent larger than their rated two-phase output; that is, to supply a balanced 300-kva. two-phase load, each transformer would have to be rated at 100 × 1.11 = 111 kva., or a total of 111 × 3 = 333 kva. capacity for the bank.

An advantage of the Taylor connection, which may sometimes be important, is that three-phase current can be delivered from points *D*, *F* and *G*, Fig. 2, at the same voltage as the two-phase current from *DE* and *FG*. Connections for doing this are shown in the diagram Fig. 3. With this connection the three-phase output can be only 92 per cent of the two-phase output

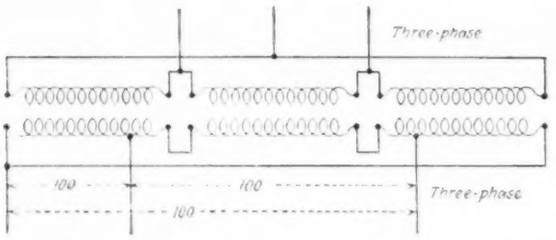


Fig. 3—Transformers Fig. 1 connected for three-phase to three-phase operation

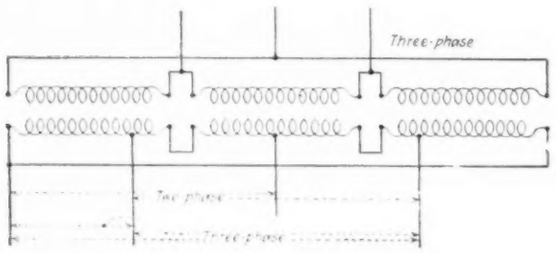


Fig. 4—Shows connections for obtaining two-phase and three-phase power at the same time

if windings *DH* and *DK* are not to be overloaded. That is, if the two-phase rating of the transformers is 300 kva., then the three-phase load that can be supplied from points *D*, *F* and G will be 300 × 0.92 = 276 kva. If the voltage is suitable for a three-phase load to be taken from points *D*, *K* and *H*, that is, the total secondary winding used, then the full kilovolt-ampere rating of the transformers can be obtained, or 111 per cent of that for the two-phase load. The chief difficulty in using the full secondary winding is that it gives an odd voltage. For example, if the two-phase voltage is 220 or 440, the three-phase voltage will be equal to 220 × 1.155 = 254, or 440 × 1.155 = 509 volts, neither being standard.

It is also possible to feed both two-phase and three-

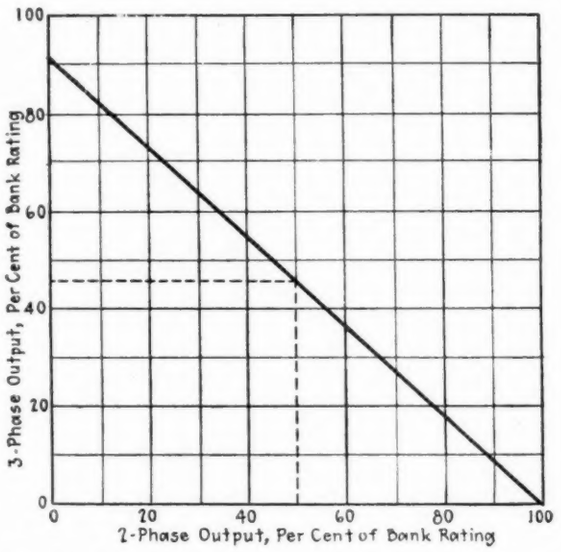


Fig. 5—Relation between the two-phase and three-phase load that may be put on a Taylor connected transformer bank

phase loads at the same time from a Taylor connected transformer bank. Fig. 4 shows these connections and Fig. 5 gives the relative loads that may be carried. If 50 per cent of the bank's two-phase rating is used for two-phase power, then 46 per cent of the bank's two-phase rating may be used for three-phase power, as indicated by the dotted lines.

As compared with other three-phase to two-phase connections, the Taylor connection has certain disadvantages and at least one advantage. The disadvantages are:

1. Three transformers are necessary where with the Scott connection only two are required.
2. These three transformers are of special design and are not all alike.
3. Slightly more material is required in the transformers than for other connections.

The chief advantage of the Taylor connection of transformers is that it can deliver two-phase and three-phase power from the same bank and at the same time without extra taps.

The ground connection for conduit or other raceways should be as near as practicable to the point where the conductors in the system receive their supply and should be made with an approved ground clamp having a solder lug (or approved solderless connector) for the ground wire. The point of attachment should be such that both the connection and the ground wire are protected from injury and still are accessible for inspection by the electrician or the inspector; paint or enamel should be scraped off to insure good electrical contact, and the job made thoroughly substantial and mechanically sound.

Fireless Boiler Generates Steam at 1,500-lb. Pressure

EVAPORATION produced by superheated steam blown through water in steel drum. Hot gases come in contact with superheater and economizer tubes only, the steam-generating drums being located outside of the boiler setting. Experimental plant successfully tried out in Vienna, Austria; 1,000-kw. plant under construction and 18,000-kw. plant started.

THERE might seem to be no way of avoiding the difficulties so far encountered in the design of boilers for extremely high pressures. It has been taken for granted that steam must be generated by the circulation of water through tubes exposed to the hot gases of the furnace. It has also been considered necessary by most designers to provide a large drum connected to the tubes in order that there might be ample space for the release of the steam from the water and sufficient heat-storage capacity to handle sudden variations in the load. The problem of designing boiler drums safe for pressures in excess of 1,000 lb. per sq.in., in spite of the weakening effect of the tube holes, has been a most difficult one, although it has apparently been solved by a rather expensive type of construction in which the drum is forged in a single piece from an ingot of steel.

That high-pressure steam may be generated in other ways than by the conduction of heat directly from furnace gases through metal to water, has been demonstrated by Prof. Dr. Löffler, of Charlottenburg, Germany, who recently published in the German engineering magazine, *Zeitschrift des V. D. I.*, an account of experiments made with a novel system of high-pressure steam generation in the plant of the Vienna Locomotive Manufacturing Co. in Vienna, Austria. While the present article is based on the information there contained and is carefully restricted to Dr. Löffler's own expressed views, the material has been rewritten to meet the needs of American engineers.

The early high-pressure experiments made by Perkins in England, Dr. Alban in Germany, and others, had no commercial effects of any consequence because in their days neither the state of the constructive arts nor the fuel situation were such as to warrant the every-day use of extremely high pressures. Even today one must face great difficulties and a considerable expense in building an extra-high-pressure plant where the boilers are merely an adaptation of the commonly used designs.

The ordinary type of boiler must depend for its circulation upon the difference in specific gravity of the columns of mixed water and vapor in the upflow and downflow tubes. To avoid burning out of the tubes

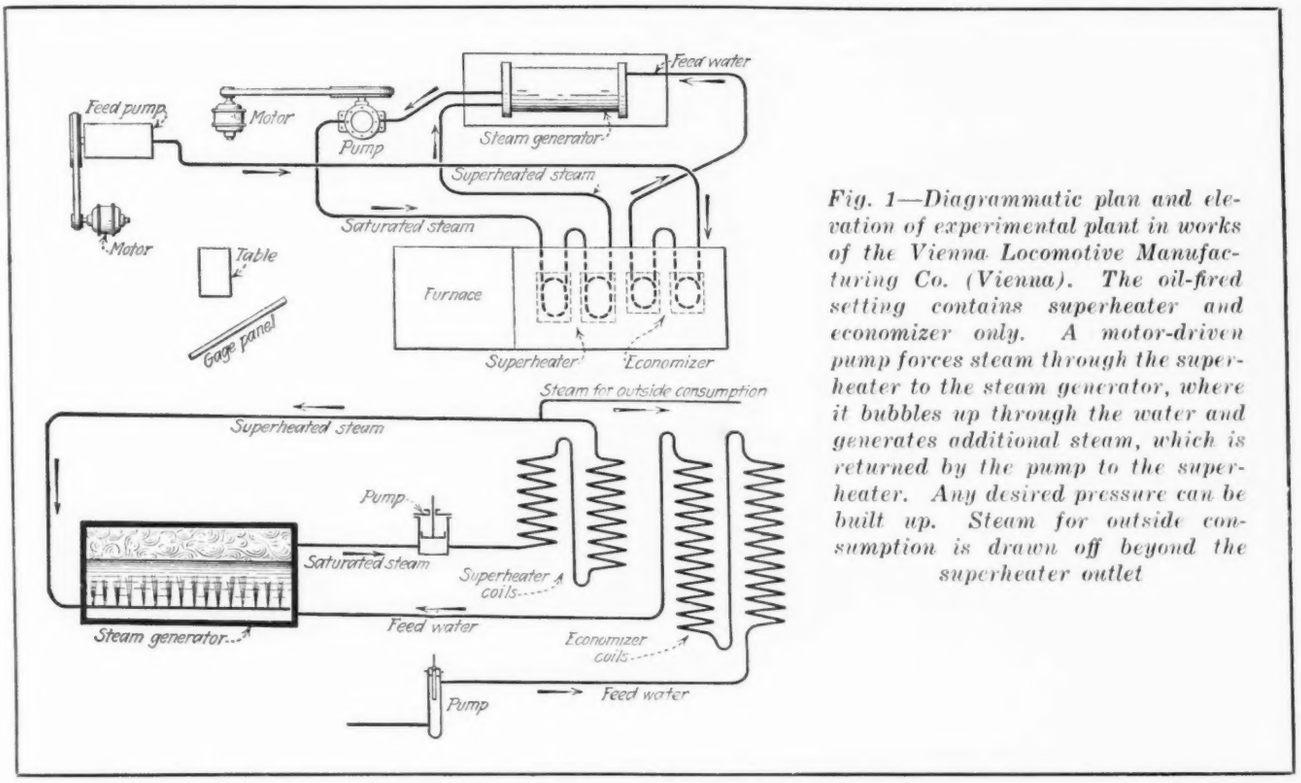


Fig. 1—Diagrammatic plan and elevation of experimental plant in works of the Vienna Locomotive Manufacturing Co. (Vienna). The oil-fired setting contains superheater and economizer only. A motor-driven pump forces steam through the superheater to the steam generator, where it bubbles up through the water and generates additional steam, which is returned by the pump to the superheater. Any desired pressure can be built up. Steam for outside consumption is drawn off beyond the superheater outlet

they must be kept scrupulously clean, which requires the use of distilled water.

The manufacture of the boilers, particularly the beading of the tube ends, becomes more and more difficult as the steam pressure rises and the walls of the steam drum become thicker. For example, a drum of 40 in. inside diameter ought to have, for 1,500-lb. pressure, a shell thickness of about 4 in. To bead tubes of 2 to 4 in. inside diameter and 0.4 to 0.6 in. thickness into such a drum requires special material and skillful handling. The great number of handhole caps required with header of sectional-type boilers increases the difficulty under these extreme conditions. Yet a drum of large water-storage capacity is necessary wherever the boiler may be exposed to a sudden demand for steam.

Doctor Löffler has gotten around these difficulties by the ingenious arrangement shown in Fig. 1. The evaporator, or steam generator proper, is entirely separated from the boiler furnace. Superheated steam serves as a medium for transmitting heat from the furnace to the water to be evaporated. It will be noted by inspection of Fig. 1 that steam travels in a closed cycle, going first from the superheater to a distributing pipe along the bottom of the drum, from which it bubbles up through the water, becoming saturated and generating additional steam in the process. A motor-driven pump forces saturated steam from the top of the drum to the superheater, maintaining a constant circulation. (An auxiliary low-pressure boiler, not shown, gets up a moderate pressure in the system to start it.) It is evident that if the fire is maintained and the circulation continued, the pressure and temperature in the steam-generating drum will rise to any desired point.

At a pressure of 1,500 lb. per sq.in. and a total steam temperature of 825 deg., it is necessary to pump 3½ times as much steam as is delivered for outside consumption. The latter is normally drawn off at the superheater outlet. The makeup feed water is forced by a motor-driven feed pump through an economizer into the steam-generating drum. The economizer is in the same setting as the superheater and is heated by gases leaving the superheater.

In this method of steam generation the only containers exposed to the heat of the fire are the superheater tubes of small inside diameter. Containing nothing but superheated steam, their capacity for storing energy is small. Temperature distribution is uniform, even at very high pressures and temperatures, so that ordinary Siemens-Martin steel may safely be used. Owing to the forced circulation of the steam no dangerous accumulation of heat in the walls can occur because of scale, sediment or bubbles of steam or gas. Check valves in the pipe lines prevent steam rushing back from the generator in case of failure of a superheater tube.

In spite of the high steam pressure the drum can likewise be made of ordinary steel without the stresses in its walls exceeding the permissible limit. Deposited scale and dirt have no detrimental effects. On the contrary they diminish the heat radiation. The thickness of the drum well may be 50 per cent less than in the usual type of boiler drum for the same pressure, because it is not weakened by tube holes or beading of the tube ends. The drum for a 1,700-lb.-pressure boiler of this type will weigh about the same as that of a 450-lb.-pressure boiler of the ordinary type.

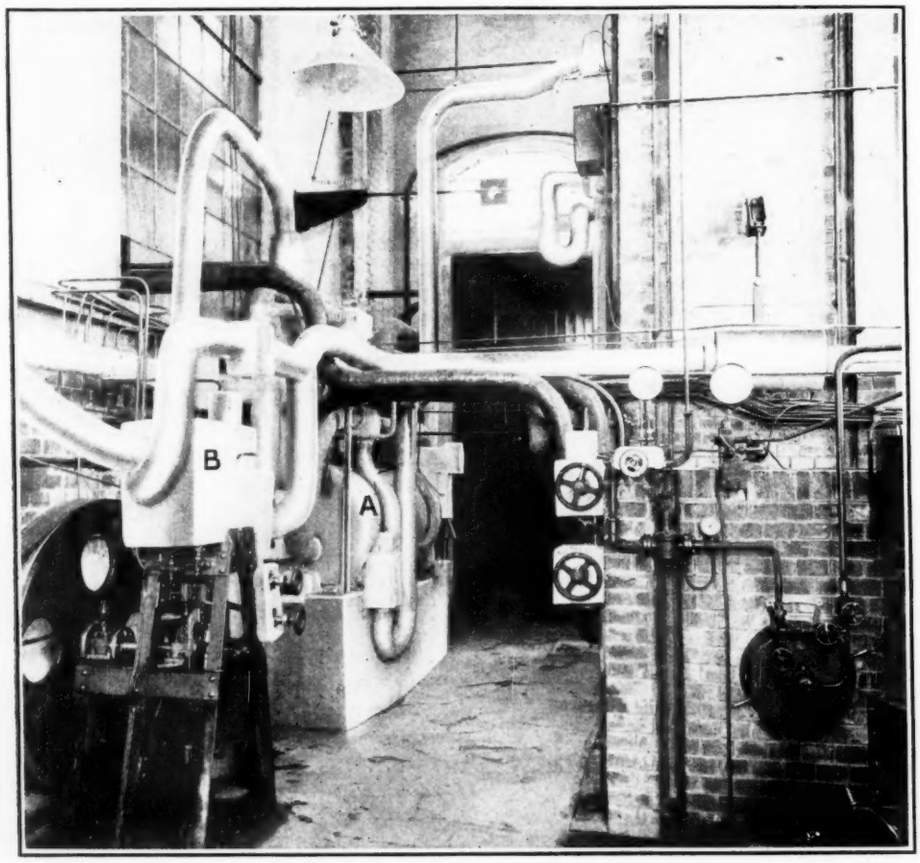


Fig. 2—Photograph of the test plant in Vienna showing the steam generator A, motor-driven steam pump B and the oil-fired setting containing superheater and economizer. This plant was operated from 6 to 9 hours a day for several weeks, producing steam at 1,500 lb. pressure and 900 deg. F. No troubles were experienced

This method of steam generation has no particular advantage for low or moderate pressures. It is recommended only for pressures exceeding 700 lb. One reason for this is that the large specific volume of steam at low pressures would greatly increase the difficulty of constructing and operating a suitable steam-circulating pump. At pressures in the range from 150 lb. to 300 lb. it would take practically the whole effective power of the boiler to run the steam-circulating pump.

The steam generator, being independent of the furnace so far as location is concerned, may be placed at the lowest point of the plant, thus doing away with the necessity for heavy supporting structures. The size of the steam generator is fixed by the heat-storage requirements of the particular installation. When the steam pressure diminishes, it must be possible to make use of the heat content of the water for steam generation in order to meet sudden demands for steam.

This method of steam generation is not a theoretical proposal. It has actually been tried out with success in the works of the Vienna Locomotive Manufacturing Co., where a testing plant was erected and put into operation in the middle of December, 1924. Fig. 2 shows a view of this plant. To keep down construction costs, the plant was not built on a large scale.

A long series of tests was made. No scale or dirt whatever was deposited on the tube walls. The pipes showed no permanent deformation although the plant was stopped every day and fired again the next day, with resulting alternate expansion and contraction.

For steam circulation a motor-driven piston pump was used. The stuffing boxes of this pump had to be made tight against a steam pressure of more than 1,500 lb. per sq.in. at a temperature of nearly 600 deg. F. This problem was solved satisfactorily. Of course the actual difference of pressure on the two sides of the piston was small, so that the question of piston leakage presented no difficulty.

While the maintenance of water level is far less important in this type of steam generator than in the ordinary boiler, two different types of water-level indicators were provided. The evaporator itself was a drawn tube with plain covers of Siemens-Martin steel shrunk into the drum ends by a special method which reduced the cost of manufacture considerably without sacrificing safety.

All devices for regulation and measurement were brought together on one board, from which a single engineer could observe the working of the entire plant.

The plant was started with steam at 180 lb. pressure taken from the existing boiler battery. After shutting off the connection to the low-pressure plant, the steam was circulated through superheater and steam generator until the pressure rose to 1,500 lb. This required one hour and a quarter.

High-pressure steam leaving the superheater at a temperature of about 900 deg. F. was taken off by a steam pipe and conducted to the low-pressure boiler after being reduced to a pressure of 170 lb. A high-pressure engine has not yet been constructed.

The plant was operated from 6 to 9 hours each day for several weeks, producing about 650 lb. of steam per hour at 1,500 lb. pressure and 900 deg. F. All parts of the plant have proved to be fully safe and tight under operating conditions. It is felt that the results of these trials justify the construction of commercial high-pressure steam plants of the same type.

The welding of high-pressure steam pipes must be carefully done and requires excellent training of the workmen. Bolted joints should be avoided as far as possible.

The exact measurements of temperatures and pressure prevailing in the plant are of greatest importance for safe operation. In high-pressure steam plants measuring instruments must therefore be provided in a considerably greater number than in low-pressure plants.

In plants of small and medium size, extremely high steam pressures can be advantageously used by reciprocating engines. In many cases these may be arranged to exhaust into the present low-pressure plant. For large stations turbines would be used. Even for pressures up to 1,500 lb. and temperatures up to 900 deg. F., their construction offers no particular difficulty.

The Vienna Locomotive Manufacturing Co. is now transforming its power station (about 1,000 kw.) for operation at 1,500 to 1,700 lb. pressure and 750 to 900 deg. steam temperature. The plant will be equipped with vertical reciprocating engines. Construction has also been started on an 18,000-kw. plant (same steam conditions) for the Witkowitz Coal Mines (Moravia). The 18,000-kw. turbine is being built by the Erste Brünner Maschinenfabrik, which guarantees a maximum steam consumption of 7.5 lb. per kw.-hr. without reheating.

It is significant that at the Witkowitz plant the space now needed for a 2,000-kw. boiler plant operating at 250 lb., will suffice for a 5,000- to 6,000-kw. plant with all auxiliaries, including pulverized-coal furnaces with large combustion spaces. The existing boilers have traveling-grate furnaces.

Engineers who have had occasion to use cast-iron pipe welded with either cast iron or bronze will be interested in the results of an investigation made by A. R. Lytle, of the Union Carbide and Carbon Research Laboratories, Inc., Long Island City, N. Y. In his paper "Effect of Heat of Bronze Welding on Cast-Iron Pipe," presented at a recent convention of the International Acetylene Association, Mr. Lytle arrived at the following important conclusions: Neither cast-iron welding nor bronze welding has any detrimental effect on the structure of cast-iron pipe. It is possible that with cast iron very high in phosphorus, the bronze-welding may weaken the structure sufficiently to lead to failure, though this is doubtful. Inasmuch as welding with either cast iron or with bronze strengthens the base metal at the point where the weld is made, it is more or less natural that line failures in overstressed pipe should occur just outside these altered zones.

The success of a grinding wheel on a commutator depends principally on using the proper cutting speed. The peripheral speed of the commutator in feet per minute added to the peripheral speed of the wheel running in the opposite direction is the actual cutting speed and may equal 7,000 to 8,000 ft. per min. satisfactorily. Commutators usually operate at 2,000 to 3,000 ft. per min., so that for good service the wheel speed should amount to 5,000 or 6,000 ft. per min. when running in opposite direction to the commutator at full speed of the commutator.

The Value of Higher Steam Pressures in the Industrial Plant*

Greatest Future for Higher Steam Pressures Lies in Industrial Plants With High Back Pressures Rather Than in Condensing Stations—Pure Feed Water the Only Serious Problem—Analysis Indicates 1,200-lb. Pressure Commercially Practicable for Industrial Plant With High Load Factor and Relatively High Power Demand

By WILLIAM F. RYAN
Power Engineer, Solvay Process Company, Syracuse, New York

THE value of steam pressures higher than 400 lb. in the central station is still being debated. There can be little question, however, that higher pressures can be used to advantage in industrial plants that use steam for manufacturing purposes.

The increase in thermal efficiency obtained by using pressures higher than 400 lb. per sq.in. in the condensing plant, can hardly exceed 20 per cent. In the industrial plant the gain may be 75 per cent or more, if the use of higher initial pressures permits the substitution for condensing units of non-condensing prime movers, whose exhaust steam is used in process.

The opportunity for generating cheap power, in the average industrial plant, is limited. If steam is used in process or for heating, power may be generated very cheaply, but only to the extent that the exhaust from the prime movers can be utilized. Many plants that use no process steam are compelled to generate their own power, on account of the high cost or low reliability of public-service current in some localities. It rarely happens that such plants have an unlimited supply of cold water for condensing purposes, and their ability to generate power at any reasonable cost is limited by the amount of steam that can be condensed with the available water. In either case, unless the power demand is low, it is desirable to get the maximum practicable amount of power out of every pound of steam before it is condensed, either in manufacturing equipment or in condensers. The necessity for this maximum of power extraction is, in most industries, increasing year by year.

The economic considerations in applying high steam pressures to the industrial plant are fundamentally different from those of the central station, and the problem must be attacked in a different manner. Here we are not concerned with cycle efficiencies. The water rate of the prime mover is as important in the industrial plant, not because a low water rate saves fuel, but because it permits the generation of more power from a given quantity of steam.

Effect of High Initial Temperature

High initial temperature is essential to the highest steam economy. Individual designers will differ as to what the present practicable temperature limit is, but there is a fairly general agreement in this country that it lies between 650 and 750 deg. F. The central station has demonstrated that 750 deg. is an absolutely practicable temperature and that a properly designed plant may operate with an average temperature of at least 725 degrees.

Fig. 1 shows how the gross output of a non-condensing turbine, per unit weight of steam used, is increased by increasing throttle temperatures. A more important point than the increase in output per unit weight of steam is that high initial temperature produces a higher quality of exhaust steam. This makes it possible to use high initial pressures without resuperheating the steam during its expansion.

Effect of Initial Pressure

Fig. 2 shows the effect of increasing throttle pressures on the output per unit weight of steam, for non-condensing turbines. This is without resuperheating of the steam during its expansion and produces exhaust steam of varying quality, depending upon the initial pressure.

It will be noted that the optimum pressure increases as the back pressure increases. With a final pressure of 25 lb. absolute there is no gain by increasing the throttle pressure above 750 lb. At 180 lb. absolute back pressure the maximum is obtained with an initial pressure of about 1,550 lb.

The higher output, according to Hirshfeld and Ellenwood[1] in Fig. 2, is chiefly due to the fact that these authorities assumed a 30,000-kw. unit, whereas the writer is considering units of 1,500 to 5,000-kw. capacity operating under part-load conditions. For the purpose of comparing one pressure with another the two methods of calculation are in reasonably close agreement.

Initial Pressure for Specific Quality of Exhaust Steam

For a plant in which the quality of process steam is of no consequence, it is only necessary to know the quantity and pressure of steam required and the amount of power to be generated. The proper initial pressure can then be determined by the method used in plotting Fig. 2.

Where a large amount of equipment (pumps, compressors, turbo-generators, etc.) designed to operate at moderate pressures and temperatures are already installed, the simplest way to obtain more power per unit of steam generated is to install higher-pressure boilers at the present boiler house, piped directly to high-pressure prime movers which exhaust into the existing live-steam mains. This makes a very simple

*Abstract of paper presented at the annual meeting of the A.S.M.E., New York, December, 1925.

[1]High Pressure, Reheating, and Regenerating for Steam Power Plants, by C. F. Hirshfeld and F. O. Ellenwood, *Trans.* A.S.M.E. vol., 45, p. 663.

installation. It is necessary, in this case, to choose an initial pressure and temperature that will give not only the desired amount of power, but also the present steam temperature at the exhaust pressure.

Fig. 3 shows the quantity of power that can be generated per thousand pounds of steam used with initial temperature ranging up to 725 deg., a final pressure of 180 lb. absolute, and a final temperature of 535 deg. Power for excitation and for boiler-feed-pump operation, which is a considerable item at the higher pressures, has been deducted from the gross output.

For initial pressures up to 656 lb. absolute, the desired final conditions can be obtained without reheating. Above that pressure a resuperheater must be employed.

For pressures requiring resuperheat, the reheat pressure is taken at 400 lb. Higher outputs would be obtained by using higher reheat pressures, especially at the highest initial pressures.

In the industrial power plant the elimination of the reheater is a material advantage. The greater simplicity of using steam without reheating is an advantage which should not be sacrificed without a material gain in some other direction.

An attempt has been made to estimate the total cost of power at various pressures for one particular set of conditions.

The assumed plant is designed to include sufficient economizer and air-preheating surface to give the same final flue-gas temperature (300 deg. F.) and as nearly as possible the same operating efficiency at all pressures. No charge is included for real estate. The cost of building is about 30 cents per cubic foot. Stoker firing is assumed and stokers and auxiliaries are designed for a maximum output of 350 per cent of boiler rating.

While the cost of a 1,200-lb. per sq.in. boiler is about four times that of a 400-lb. unit, the cost of the complete high-pressure plant is less than twice as great.

The cost of a turbo-generator increases relatively less with increased pressure. While the prices vary widely with different designs, a machine for 1,200 lb. initial pressure and 180 lb. back pressure will not cost more than 50 per cent more, installed, than a machine of the same size and back pressure for 400 lb. initial pressure.

The resulting comparative costs per unit of output[2] are shown in Fig. 4, which is only a graphic representation of the estimated costs of power and does not indicate the best steam pressure to be used. As previously stated, the problem in the industrial plant is to get the required power from the available steam. A chart like Fig. 4 will show how much of it may be obtained more cheaply from high-pressure turbines than from other available sources.[3]

In plants where the power load is low in proportion to the exhaust-steam demand, higher initial pressures may be desirable in order to permit the use of higher back pressures.

The capacity of many kinds of steam-heating equipment is increased with increased pressure or, conversely, the size and cost of equipment for a given output is decreased with increased steam pressure. Higher pressures in evaporating processes usually increase the capacity, the heat economy, or both.

Many plants are using live steam in process work at 40 to 100 lb. pressure. Reducing the pressure from that supplied at the boilers often results in a troublesome degree of superheat as well as in a waste of available energy. High-back-pressure prime movers remedy this situation.

More advance has been made by industrial plants in the field of high back pressure than in the field of high initial pressure. The latter is a logical development from the former.

Manufacturers of heating equipment such as evaporators have made little change in limiting pressures in the last twenty years. Pressures up to 100 lb. were

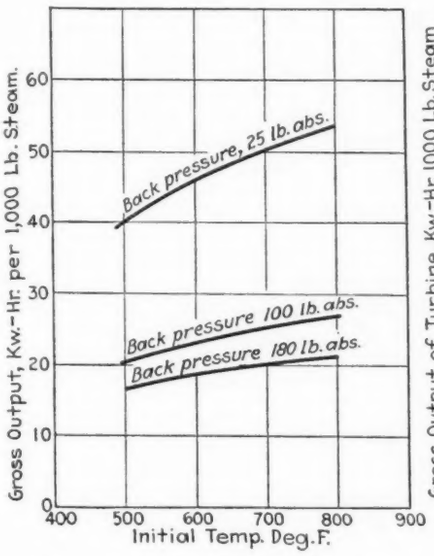

Gross Output, Kw.-Hr. per 1,000 Lb. Steam
Back pressure, 25 lb. abs.
Back pressure 100 lb. abs.
Back pressure 180 lb. abs.
Initial Temp. Deg. F.

Fig. 1—How steam temperature affects power obtainable from steam at 565 lb. absolute pressure

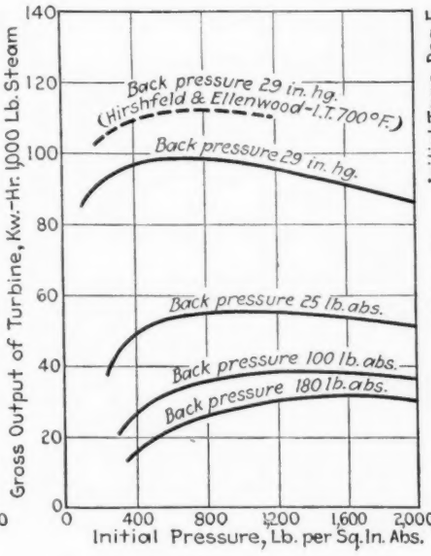

Gross Output of Turbine, Kw.-Hr. 1,000 Lb. Steam
Back pressure 29 in. hg. (Hirshfeld & Ellenwood-I.T. 700° F.)
Back pressure 29 in. hg.
Back pressure 25 lb. abs.
Back pressure 100 lb. abs.
Back pressure 180 lb. abs.
Initial Pressure, Lb. per Sq. In. Abs.

Fig. 2—Effect of initial pressure on power obtainable from steam at 725 deg.

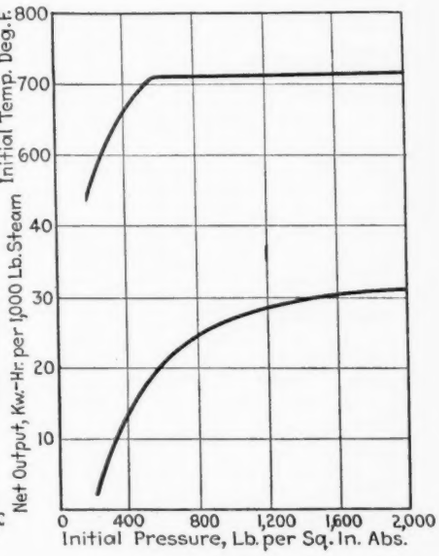


Fig. 3—Power output and initial temperature with exhaust steam at 180 lb. abs. and 535 deg.

[2]Delivered coal cost $5 per net ton. For other assumptions see original paper.

[3]This point is further elaborated in the editorial pages of this issue.

used on large evaporators at least twenty years ago, and very few, if any, large evaporators have been built for higher pressures.

While temperature increases rather slowly with increased pressure, it is usually possible to increase the efficiency of an evaporating process by increasing the steam pressure. The advantages of higher pressure for process, particularly in plants with a low power demand, are so great that considerable development in this direction may be expected in the near future.

Feed Water for High-Pressure Boilers

Obtaining suitable feed water is one of the more serious problems that will confront the majority of industrial plants contemplating the use of high-pressure boilers.

The decreasing solubility of calcium sulphate with increasing temperature makes many treated waters that

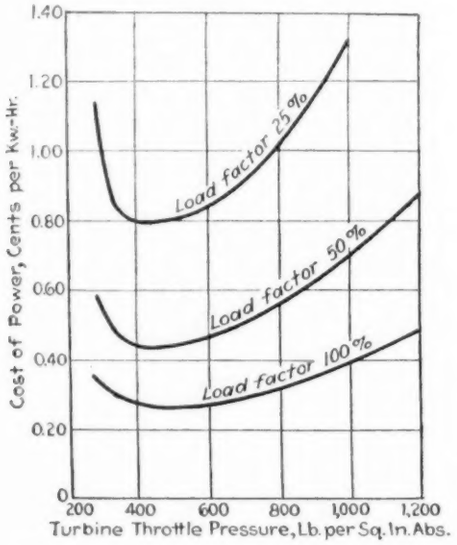


Fig. 4—Effect of initial pressure on total cost of power. Throttle temperature 725 deg., exhaust 180 lb. abs. and 535 deg.

Note that best operating pressure may greatly exceed that of minimum power cost.

are fairly satisfactory at 200 lb. pressure almost unfit for use at 600 lb. Dilution by blowdown is more costly at high pressures. The consequences of a rupture, resulting from scale formations, are more to be feared at the higher pressures. If possible, only distilled water should be fed to high-pressure boilers.

The condensing plant, provided the condensers are tight, returns 90 per cent or more of the total feed to the boilers as practically pure distilled water. The quantity of makeup is so small that the raw water can be evaporated without much expense, and it is possible to feed boilers with water almost free from solids. In the industrial plant, condensate may be returned from some apparatus, but with direct contact heaters, such as distillers, vulcanizers and digesters, no condensate can be recovered.

In such cases a pure water supply could be obtained by condensing the exhaust in single-effect evaporators. These evaporators, fed with raw water, supply vapor to the process, and the condensed exhaust steam is returned to the boilers.

The cheapest method of obtaining pure feed may be, in the majority of cases, to evaporate the total makeup, multiple-effect, with steam at fairly high pressure.

Commercial Limitations

The limiting pressure for present-day plant design is set, not by the calculated minimum cost, but by the ability of manufacturers to supply the required equipment.

At this writing the boiler and valve manufacturers are the only ones who appear entirely willing to supply equipment for pressures much higher than 600 lb. gage.

Boilers of practically any capacity may be obtained for pressures up to 1,200 lb. Valves at least as large as six-inch are obtainable for the same pressure.

At least one turbine manufacturer is willing to quote on small, high-back-pressure turbines for initial pressures of 1,000 to 1,200 lb., but this company prefers to build its first machine of this kind in a larger size than could be used by the majority of industrial plants.

Engines are in use operating at 400 lb. gage, and at least one engine builder is willing to supply reciprocating equipment for pressures up to 600 lb. gage.

Boiler, turbine and valve manufacturers accept temperatures up to 750 deg., but the engine builders at present set a limit 100 deg. lower.

Central stations have demonstrated the practicability of 600 lb. as a working pressure, and of 750 deg. as a working temperature. They will soon demonstrate whether or not 1,200 lb. is equally practicable. This leaves very little development or experiment necessary for the industrial plant. Boilers, boiler auxiliaries and valves would be the same in the industrial plant as in the central station. Turbine design should be simpler on account of the much lower range of temperatures in the high-back-pressure machine than in the condensing unit. Leakage and other handicaps to the smaller-sized unit are not so serious in this type of machine, where all the heat not used in actual work or lost in radiation is available for use in process.

When both the plant designer and the equipment manufacturer are thoroughly awake to the possibilities of higher steam pressures in the industries, commercial development in this field should be even more rapid than it has been in the central station. Because the gains are greater there, and the problems less difficult, it is probable that the eventual field for the highest steam pressures is in the industrial plant.

One of the most common causes for burnt spots on collector rings is vibration which makes the brush break contact with the ring, producing a burnt spot on the surface. This condition is especially troublesome if the vibration is of periodic character, breaking the contact of the brush repeatedly at the same spot on the ring. It may result from unequal expansion of the ring destroying its true cylindrical form as the machine warms up. This fault is most likely to occur with spoked rings of light cross-section. In some cases the trouble may be corrected by grinding the ring after it has been heated up to operating temperature. It is well, where possible, to perform this grinding operation at the full running speed of the machine, as at this speed there may be a distortion that does not exist at lower speeds.

Industrial Plant To Install Steam Accumulator

A LARGE manufacturing company[1] recently decided upon a complete remodeling of its steam plant. A point of interest is the fact that the entire power required for the operation of the plant will be obtained by expanding the process steam through single non-condensing turbines of a type new to this country. The plans also call for the installation of a steam accumulator and the arranging of the steam plant in accordance with the accumulator system.

Steam is at present generated at about 100 lb. pressure and without superheat in two water-tube boilers and a battery of Lancashire boilers. The average yearly boiler efficiency does not exceed 65 per cent, owing to the comparatively inefficient boiler-house installation and the heavy fluctuating steam demands. Most of the steam is required for the purpose of evaporation, which process is divided into multiple-effect evaporators and the vacuum pans. The multiple-effect evaporators are taking steam at 15 lb. pressure. Large amounts of steam at this pressure are also required for heating process water. Since the evaporators are working continuously, no large fluctuations occur in the consumption of this low-pressure steam. On the other hand, the evaporation in the vacuum pans is an intermittent process. Each cook requires about 90,000 lb. of steam and four vacuum pans are installed. At the starting of a cook, where the concentration of the solution is low, low-pressure steam may be used and with increasing concentration steam of 90 lb. pressure is required.

The demand for steam in the refinery varies widely and within short periods. The average consumption runs around 125,000 lb. an hour, dropping at times to 70,000 lb. an hour and increasing again to over 170,000 lb. an hour.

A limited amount of power, chiefly for pumping purposes, is at present generated in a few reciprocating engines exhausting into the 15-lb. steam line. By far the larger part of the required power is purchased hydro-electric power.

New Arrangement of Steam Lines in the Power Plant

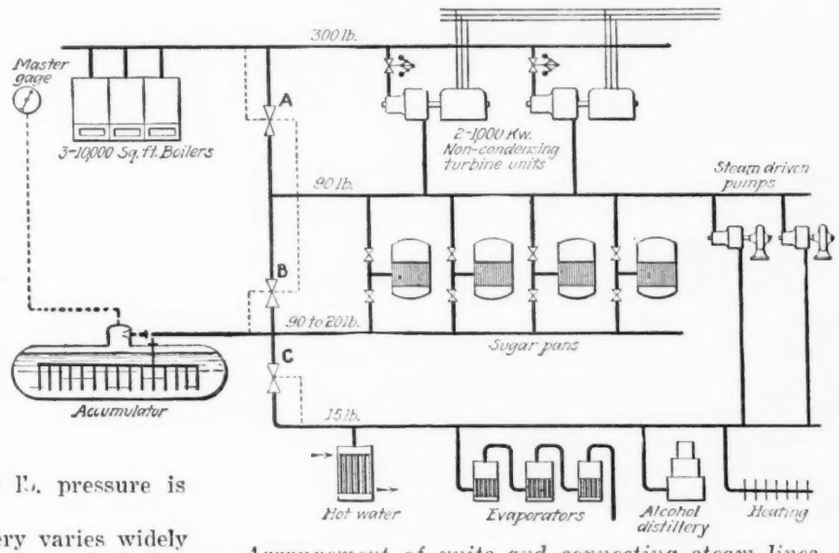
The layout of the new plant is shown in the illustration. The new boilers will be designed to deliver steam at 300 lb. pressure and 100 deg. superheat to non-condensing turbines. Three boilers of 10,000 sq.ft. of heating surface each will ultimately be installed. Two boilers will thus be able to carry the average load of 125,000 lb. of steam per hour at 200 per cent of rating, leaving one boiler as a stand-by.

Two non-condensing turbo-generators, each of 1,000 kw. capacity, will be installed, to work between the initial pressure of 300 lb. and a back pressure of 90 lb. the turbines will be of the Erste Brünner type, built by Stork Bros., of Holland. A description of this type of turbine appeared in the Sept. 23, 1924, issue of *Power*.

At full load, of 1,000 kw., each turbine will require 48,000 lb. of steam an hour and with both turbines operating at full load, the total steam flow of 96,000 lb. an hour will be well below the average steam consumption of the refinery. Consequently, there will be no danger that the turbines will deliver steam in excess of the requirements for process work, which excess steam would have to be relieved. It is expected that one unit will be able to carry the entire electrical load of the refinery for the first period after the completion of the new plant.

The regulation of the turbines is by speed governor only, no pressure regulation being required. If more steam is required in the 90-lb. steam main than is supplied by the turbines according to the demand for power, such steam is supplied directly from the boilers through regulating valve *A*.

The accumulator is connected to the steam system



Arrangement of units and connecting steam lines

by means of the two regulating valves *B* and *C* and is allowed to work in the pressure range of from 90 to 20 lb. The accumulator is charged through regulating valve *B*, and it may again supply this steam directly to the vacuum pans or through reducing valve *C* to the low-pressure main, carrying 15 lb. steam pressure.

The vacuum pans are connected both to the 90-lb. main and the accumulator line. Each cook is at first started with steam taken directly from the accumulator and with increasing concentration of the solution the cooking is finished with steam taken from the 90-lb. steam line. All the other units, such as evaporators, distilling columns, hot-water heater, feed-water heater and room heating, are connected to the low-pressure system. A number of pumps will be driven by small turbines taking steam from the 90-lb. line and exhausting into the low-pressure system.

The operation of the plant is as follows: A constant amount of steam corresponding to the average steam consumption of the refinery is generated in the boiler house. All steam that is not allowed to pass through the turbines is automatically passed through regulating valve *A*, which works as an overflow valve for the boiler-house main and thus maintains constantly 300 lb. pressure in this line.

[1] At the request of the author the name of the company is omitted.

The 90-lb. steam main receives steam from the non-condensing turbines and through regulating valve *A*, which is the total steam flow supplied by the boilers. A varying amount of steam is now supplied from the 90-lb. main to the vacuum pans, and the rest is automatically passed through regulating valve *B*, which serves as an overflow valve for the 90-lb. main and, therefore, maintains this pressure constant. The reducing valve *C* admits as much steam as necessary to the low-pressure main to maintain 15 lb. pressure on the line.

All fluctuations in the consumption of steam, wherever they occur in the refinery, are automatically transmitted to and taken care of by the accumulator.

The boiler pressure as well as the 90 and 15 lb. pressure will automatically be maintained constant by regulating valves *A*, *B* and *C*. Besides the function of these valves as previously explained, they will also act as limit pressure valves and close in case the accumulators, because of improper attendance of the boiler house, should become completely charged. Should, on the other hand, the accumulator happen to be completely discharged, these valves would act as reducing valves, securing a sufficient supply of steam to the 90- and 15-lb. systems. The valves, therefore, form the centralized steam switchboard of the entire plant, providing for an even distribution of the steam and constant steam pressures throughout the refinery. The valves are operated by oil pressure, supplied by a small electrically driven gear pump.

The accumulator, which is of the Ruths type, will have a diameter of 16 ft. and a total length of 55 ft. corresponding to a volume of 10,000 cu.ft. It will be capable of storing 40,000 lb. of steam in the pressure range from 90 to 20 lb. gage.

The accumulator is designed to take care of all the fluctuations in the consumption of steam occurring during normal operation in any part of the refinery. This will allow the boilers to be operated at a practically constant rating, any regulation necessary being made in accordance with the accumulator pressure, which is indicated in the boiler house by a master gage. As long as the accumulator pressure varies within normal limits, the boilers are operated at a constant rating. Only in case the accumulator pressure tends to reach its highest or lowest level, is it necessary to change the steaming rate of the boiler.

The ability to operate the boilers at practically a constant rating, through the employment of the accumulator to take care of the fluctuations in steam demand is expected to give a much higher over-all efficiency than would be the case if the fluctuations were taken directly by the boilers. In addition a considerable saving is expected in boiler furnace maintenance and in the labor required to operate the plant.

In his report for the recently ended fiscal year, the director of the United States Coast and Geodetic Survey recommends detailed study of the tides and currents in the harbors of Boston, Portland, Me., and Portsmouth, N. H. This work will probably be commenced the coming year, supplementing that already carried on at New York Harbor, San Francisco Bay, Delaware Bay and other points. While the direct purpose of this work is to assist navigation, the results obtained may prove of some value in connection with the analysis of various tide-power projects now under consideration.

Oil-Engine Fuel-Pump Adjustments

By Robert Melrose

THE Diesel engine, like any other type of prime mover, reflects in its operation the degree of efficiency possessed by the staff responsible for its care and maintenance. New engines, of course, can be depended on to run for some considerable time with only minor adjustments, but the engine that has been in operation for several years requires a little additional attention owing to parts wearing out and the usual depreciation that takes place in all machines.

The operator who takes an interest in his work will undoubtedly make himself thoroughly conversant with

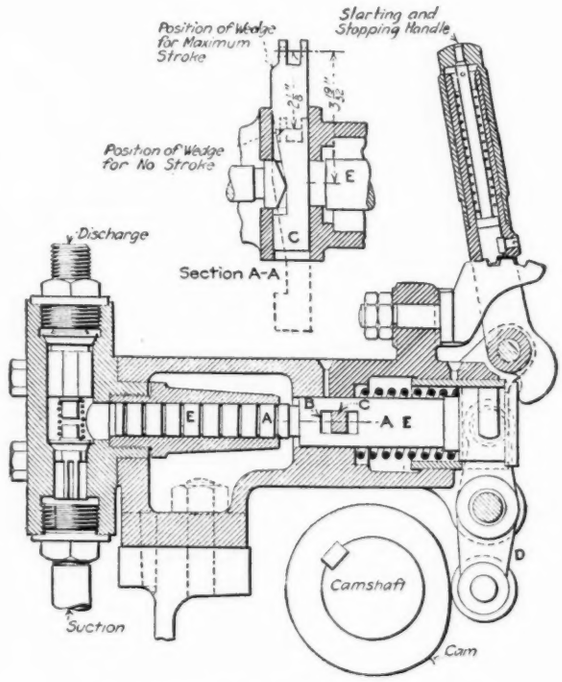


Fig. 1—Variable plunger stroke pump

all the details of the various pieces of mechanism, so that in the event of any part becoming defective and requiring overhaul or repair, permanent or temporary, he will be forearmed to the extent that he will not be compelled to waste time experimenting. An understanding of the construction and principles of operation of the different parts of the engine, besides being essential for good results, produces confidence in the operator and tends to dispel that air of mystery which still adheres to the Diesel engine in the minds of some engineers.

In his associations with Diesel engine operators, the writer has observed that the subjects most frequently requiring explanation are fuel pump adjustment, valve timing, balancing of power in multi-cylinder units and governor adjustments.

Fuel pumps may be classified under two headings—those wherein the supply of oil per stroke is controlled by the governor regulating the time of closure of the pump suction valve, and the type where the amount of oil delivered is controlled by altering the stroke of the

fuel-pump plunger. The former type appears to find favor with most engine builders on account of the simplicity of fuel control.

In Fig. 1 is shown a pump in which the fuel charge is controlled by altering the stroke of the plunger *E* through the wedge *C* which passes through the slot *B* and is shifted by the governor.

The second type of fuel pumps is illustrated in Fig. 2. Here the pump plunger *A* is driven by the constant stroke eccentric *B*. The eccentric *E* drives the suction-valve plunger *D* and the latter by striking the dog *F* opens and closes the suction valve. The dog *F* is

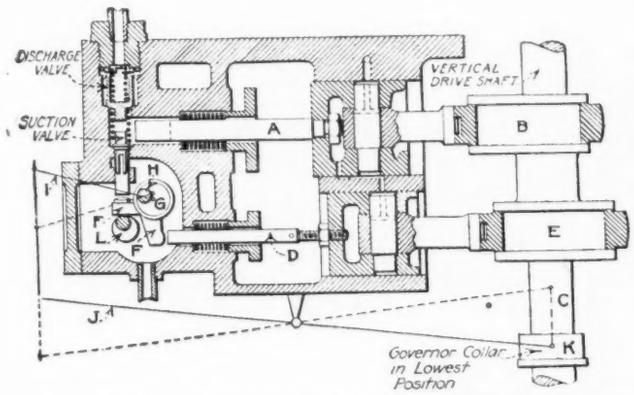


Fig. 2—Pump with a variable suction-valve timing

mounted on an eccentric *G* keyed to the shaft *H*. The governor controls the period of suction-valve opening by shifting the shaft and eccentric through the rod *J*. The cam *L* is used to lift the valve off its seat when stopping the engine.

An examination of the indicator diagram is undoubtedly the most effective method of determining the condition of each individual fuel pump, assuming that the design conforms to modern practice and that separate pumps are provided for each cylinder. This procedure will probably assist in locating the trouble without resorting to the expedient of dismantling the entire mechanism. However, engineers should recall that pronounced irregularities in the lines of the indicator diagram are not caused, as a rule, by defects in the fuel pump. The characteristics of the diagram will remain practically the same for all conditions but the area will vary; for instance, grit locating on the pump suction valve seat and preventing the valve from reseating properly will produce a diagram similar to that which would be obtained under light load conditions, owing to the curtailed amount of oil delivered

In most engines each fuel pump has an adjustable tappet by means of which the quantity of oil controlled by the governor can be varied independently of the other pumps. This fitting plays an important part in the balancing of the engine or distribution of power. It should be observed, however, that should one cylinder suddenly begin to show a falling off in power, it is not considered good practice to readjust the fuel pump without first seeing that the restriction is not caused by some foreign substance in the oil passages or the fuel pump itself. Such a condition will tend to produce an overload in that cylinder in the event of the system clearing itself after the tappet has been adjusted.

Leaking pump stuffing boxes will, of course, adversely affect the power output if unattended to and will show light load conditions on the indicator diagram. Such leaks are now a thing of the past, as manufacturers are paying more attention to these details. Some engines have pumps in which the packing is dispensed with altogether, tightness being insured by substituting a long ground sleeve, the plunger and sleeve being lapped to a fit.

The fuel pump is not confined to any particular location on the engine. It can be driven off an extension of the crankshaft, from the vertical shaft transmitting the motion from the crankshaft to the camshaft, from the camshaft itself or by an independent shaft driven from the crankshaft through a train of gears. All of these methods are utilized in modern practice. The pump is thrown out of action by raising the suction off its seat or by moving the plunger to the end of the stroke and retaining it there by means of a hand-operated lever. The latter method is adopted where the suction stroke of the pump is automatic or, to explain it more clearly, where the pump-driving mechanism is not directly attached to the plunger, but merely engages with it to execute the discharge stroke and in doing so compresses a coiled spring which returns the plunger again to the extreme end of the stroke as the driving eccentric recedes. The hand-operated lever can also be utilized to prime the fuel system previous to starting up; other types require a separate hand pump for priming purposes.

Oil-Engine Costs in Ice Plants

An ice plant was erected in Vineland, N. J., during the latter part of the year 1922. The original plan of the corporation was to manufacture 50 tons of ice a day and to maintain cold-storage space for holding farm products. It was planned to increase the space as demands were made. At the present time the capacity is 125,000 cu.ft.

The power units consist of two Ingersoll-Rand oil engines direct connected to ammonia compressors, each having a capacity of 30 tons of ice a day, and one 100-hp. unit direct connected to a 60-kw. generator supplying energy to the motor-driven auxiliaries. Fuel oil costs 6.4 cents a gallon and lubricating oil 53 cents.

The plant was started in April, 1924, and has operated continuously since that time. The average production for the plant is 52.2 tons of ice a day, and the average cost of fuel and lubricating oil is 28 cents a ton of ice, as no outside power is used. In addition, it includes the cost of refrigerating the cold-storage space, which is maintained at a temperature of 33 deg. F.

In the elementary theory it is commonly assumed that the power that a given belt can transmit at a given speed is independent of the pulley diameter. However, experimental results made public in a recent bulletin (*R*-13) of the Leather Belting Exchange confirm the experience of the practical man that belts pull better on pulleys of larger diameters. Experiments were made on cast-iron pulleys ranging from 6 to 36 in. in diameter, the driving and driven pulleys being of equal diameter in each case. The shaft speed was regulated to give a belt speed of 2,000 ft. per min. in each case. At 2 per cent slip the power transmitted ranged from 17 hp. for the 6-in. pulley to 24 hp. for the 36-in. pulley.

Rules for General Operation of Prime Mover Plant*

Small Turbines on Auxiliaries—Starting

1. Inspect the reduction gear to see that no water has accumulated in the case and that there is enough, but not too much, oil.
2. *See that the exhaust valve is open.*
3. See that the relief valve on the turbine casing is in operating condition.
4. Inspect the oiling system and the oil strainer, if it is accessible.
5. See that all drains are open.
6. If an emergency trip is provided, see that it is set.
7. See that the overload nozzle valves are closed.
8. If condensate has accumulated in the auxiliary steam line, drain it off.
9. Open the throttle slightly and run the unit at slow speed.
10. Sound the turbine.
11. Inspect the oiling system before and after starting to see if it is functioning properly.
12. Open and adjust the proper supply of water to the oil cooler and bearing water jackets, if any.
13. Bring the turbine up to speed gradually.
14. Close all drains when the turbine is up to speed.
15. If turbine glands are of the water-sealed or steam-sealed type, see that they are properly sealed.
16. Test the governor by pushing it to the closed position to see if this will cause the turbine to slow down.
17. Overload nozzles are to be used only when necessary.

Small Turbines on Auxiliaries—Shutting Down

1. See that load is off the turbine whenever practicable.
2. Close the throttle valve.
3. Do not shut off the oiling system until unit comes to rest.
4. Close exhaust valve every time machine is shut down.
5. Open the drains.

Small Turbines—Periodic Overspeed Test

1. See that the load on the turbine has been removed, when practicable.
2. Apply a tachometer to the shaft and note that normal speed is maintained by the governor at no load.
3. Continue to observe the speed by means of the tachometer and force the governor arm against the spring, allowing the turbine to speed up, not exceeding 2 per cent above the speed at which the manufacturer recommends setting the emergency trip.
4. Note the speed at which the overspeed device trips the throttle, and if this speed is more than 2 per cent above the speed at which the manufacturer recommends setting the emergency trip, locate cause and make any necessary adjustments to governor mechanism and safety devices.
5. Be sure tripping mechanism is correctly adjusted before putting machine into service.

Slide-Valve Engines on Auxiliaries—Starting

1. Open the exhaust valve.
2. Open necessary valves on auxiliaries connected to the engine.
3. See that the drains and cylinder cocks are open.
4. See that the lubricator is acting properly and inspect the oiling system before and after starting.
5. Open the throttle valve enough to admit steam to warm up cylinder without turning engine.
6. Bring the engine up to speed gradually and inspect the operation of the governor and safety devices.
7. Close the drains.

Slide-Valve Engines on Auxiliaries—Shutting Down

1. Close the throttle and stop the engine in the starting position.
2. Shut off the oiling system when the unit comes to rest.
3. Close all valves on auxiliaries connected to engine.
4. Close the valves on the lubricator.
5. Open the drains before closing the exhaust valve, if non-condensing.
6. Exhaust valve should be closed and drains open.

Small Motors on Auxiliaries

Induction Motors Started by Compensator—Starting

1. Inspect the oiling system.
2. See that the compensator handle is in the "Off" position.
3. Close the motor main switch.
4. Throw the compensator handle to the starting position and note that the rotor turns over, or watch ammeter if it is impossible to see motor.
5. When the motor comes up to maximum speed on the starting position, throw the compensator handle to the running position quickly.
6. Inspect oiling system and note if it is functioning properly.

Induction Motors Started by Compensator—Shutting Down

1. Trip compensator.
2. Open the motor main switch when compensator handle is in "Off" position and motor has begun to slow down.

Motors Started from Automatic Control Panel—Starting

1. Inspect oiling system.
2. See that the controller is in the "Off" position.
3. Close the motor main switch.
4. Move the controller handle to the required starting position.
5. Note that the starting operations are in proper sequence, and that the motor comes up to the required speed.
6. Inspect the oiling system and note that it is functioning properly.
7. Inspect the slip rings if motor is of the slip ring type.

Motors Started from Automatic Control Panel—Shutting Down

1. Move the controller handle to the "Stop" position.
2. Open the motor main switch, wherever practicable. [Note: If motor main switch is knife type, open switch when rotor has stopped turning.]

*Excerpt from revised "Operating Code Manual," issued December, 1925, by N.E.L.A. Prime Movers Committee.

Accident Prevention

AT VARIOUS sessions of the annual meeting of the American Society of Mechanical Engineers, the following proclamation by President William F. Durand was read by the chairman:

> The accident situation in this country has reached appalling proportions, taking an annual toll of approximately 80,000 lives, while disabling over 2,000,000 more for varying periods. This yearly loss is greater than that sustained by our armies during the entire period of the World War, and has become still more serious in several of its aspects.
>
> Compared with other nations, there are killed in peaceful America per million of population almost twice as many as in France or Japan, more than twice as many as in Great Britain, and four times as many as in Denmark.
>
> The direct loss has been estimated to run each year into billions of dollars, while the indirect loss is beyond calculation, and our country is now confronted with a problem, already sufficiently grave, which may ultimately prove to be the greatest in its history.
>
> Additional to and dwarfing all such losses, however, are the human suffering and misery engendered, the extent of which none can either measure or conceive, but which must exert an increasingly retarding effect on the advancement and uplift of our country and a stain which can never be effaced.
>
> The members of this society, therefore, in recognition of the situation, which calls for the best efforts of every citizen having the welfare of our country at heart, pledge themselves and this society to continued and unremitting effort in this greatest of all human endeavor—the work of accident prevention.

In each case the session was declared suspended for one minute for the silent consideration of the gravity of the accident losses with which we are confronted, as an indication of acceptance of the pledge in the concluding paragraph.

The importance of this matter cannot be over-emphasized, and *Power* calls upon each reader to join with the members of the Society in accepting the foregoing pledge as a statement of his own purpose, not only in his work, but in all the activities of life.

Don't Lean Too Heavily on a Formula

RISING to his feet in public for the first time, the embarrassed speaker may seek support for his feeble confidence by leaning on a near-by chair. Sometimes the chair wabbles or even gives way entirely, with disastrous effect upon any shreds of dignity he may have retained.

Formulas are much like chairs. Some are staunch; some are satisfactory supports to one sitting gingerly in approved tea-party style; others are almost certain to collapse unless the sitter is skilled in poising his weight on the one sound leg.

Some men possess what is known as a reverence for the printed page. To them anything in print must be true. Happily, this attitude is rapidly passing away with increasing education and is being replaced by a healthy skepticism. The day has about arrived when print, like conversation, must stand on its merits. But mathematics, a more alien language than English to most of us, still has its blind devotees who look upon any formula, at least any printed formula, as an infallible instrument. The man with little training in experimental work or the technique of deriving formulas is a little more likely to fall into this error than his better-schooled brother.

A good formula—and there are many such—is of more practical value than a good chair. Even many of the rickety formulas—for example most of the chimney formulas now in use—are of value in skilled hands. But one must learn their limitations and weak points if he would hope to keep off the floor.

This is the disadvantage under which the "handbook engineer" must labor. All the formulas are in his little book, but he may lack the discrimination to use them wisely and safely. Many must, of necessity, start as handbook engineers, but it behooves them to study down beneath the formulas to fundamental principles as early as possible in their careers in order that they may graduate into the ranks of those who can use handbooks without being their slaves.

Boiler Design

BOILERS for moderate pressures may be designed in many ways. The principal factors for which provision must be made are safety in construction, tightness in joints, provision for expansion, easy steaming and accessibility. A skillful designer can take care of these factors.

Modern high-pressure boiler design presents more formidable problems. Thicker drums must be used and riveted joints become affairs of some moment. Expansion troubles increase and rolled joints are more difficult to keep tight. High ratings are demanded and water circulation and steam liberation must function properly. High ratings also cause high draft losses with standard methods of baffling, and single-pass boilers are being developed to reduce these losses.

Modern furnace construction will profoundly influence new boiler designs. Engineers now have a better understanding of combustion phenomena and of the preponderating influence of radiant heat on effective heat transfer into metal tubes. The advantages of preheated air, minimum excess air, complete combustion in the furnace and maximum furnace temperature are now appreciated. These are not only influencing methods of firing and furnace design, but must ultimately cause modifications in the boiler design itself. Water-cooled side walls and water screens for furnaces have proved necessary and thermally economical under these new combustion conditions. Such surface should logically be part of the boiler heat-absorbing surface. Test data

indicate that such surfaces are capable of absorbing heat at a very high rate, so much so that a great part of the total heat of combustion is absorbed by these exposed water-cooled surfaces.

Boiler designs to meet these modern conditions and to be capable of carrying high ratings contemplate a complete water-cooled furnace with or without refractory lining, as is deemed desirable by combustion requirements and air preheaters. The trend is definitely toward lower and less costly boiler houses, so that the new boiler design must be low and compact and require the minimum room to withdraw tubes. One can only conjecture on the ultimate design, but it is evident that quite radical changes in boilers may logically be expected as a result of these new economic conditions.

Additional Thoughts on Higher Steam Pressures

ENGINEERS of industrial power plants have been watching with interest and even amazement the rapid growth of steam pressures in central stations. While their problems are different in many ways, central-station developments nearly always teach them something of value. Constructive thinking along this line was crystallized by William F. Ryan in his paper presented at the annual meeting of the A.S.M.E.

Every engineer who wants to keep abreast of the times should read the abstract of Mr. Ryan's paper on page 1010 of this issue. It will set him thinking. Then he should turn back to the discussion reported on page 884 of the December 8 issue, to get the reaction of other prominent engineers to Mr. Ryan's line of reasoning.

The outstanding facts seem to be about as follows: First, the industrial plant has, in many cases, more to gain than the central station from higher pressures; second, this is particularly true in cases where high back pressure makes it impossible (with present throttle pressures) to meet the power requirements without generating steam beyond the process requirements; third, there is little or no advantage in carrying the steam pressure beyond that necessary for generating the power requirements from the process steam.

Since process pressures and the relation between power and steam requirements vary widely, it is obvious that some plants will justify much higher pressures than others. Cases probably exist where 1,200 lb. throttle pressure will eventually pay, assuming the availability of dependable equipment at reasonable cost.

Feed-water supply, it is true, presents a problem. It is generally conceded that the production of 30 per cent or more distilled makeup by evaporators, as commonly constructed and operated, is ordinarily too costly for consideration. Perhaps some new plan of distillation can be devised to overcome this objection. Lime-and-soda treatment is said to be unsuitable for sulphate waters used in extremely high-pressure boilers with a high percentage of makeup. Several experts have predicted that sodium phosphate treatment will meet this objection to higher pressures.

Attention should be called to the second paragraph, second column of page 1011 (this issue) and to the caption of Fig. 4. These point out that the most economical operating pressure may greatly exceed that which gives the lowest total cost per kilowatt generated by the process steam.

This may seem to be a paradox, but is in reality sound logic for the industrial plant. For example, 500 lb. may give the lowest cost per kilowatt, say eight mills, but may not permit generating all the power requirements from process steam. It might then pay to run the pressure up to eight hundred pounds, if necessary to generate all the power needed, thereby increasing the total cost to one cent per kilowatt-hour, rather than purchase excess power at, say, two cents per kilowatt or produce additional steam solely for power generation.

Application of the principles developed by Mr. Ryan to the study of existing plants will frequently lead to rather surprising conclusions. What is needed above all else is careful analysis and an open mind.

The Middle Road

UNQUALIFIED advocates of the isolated plant on the one hand and of purchased power on the other are equally prone to lose sight of the fact that in many cases a combination of purchased and home-made power may be more economical than either alone.

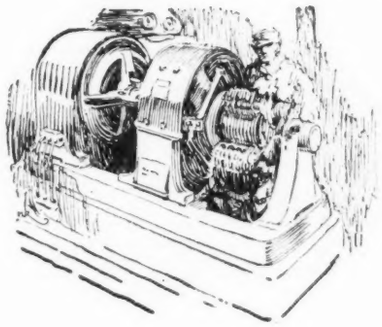
In office building and in metal-working plants, particularly, the principal use of steam, aside from power generation, is for heating buildings. It rarely happens in plants of this kind that condensing operation is possible. While power may be generated at low fuel cost from the heating steam for half the year, the coal consumption chargeable to power rises sharply as warm weather approaches. It may thus happen that power can be purchased during the non-heating months for somewhat less than the fuel and labor costs of generating one's own power. While the saving is not likely to be extremely large, in view of the fact that no capital charges on power-generating equipment already installed may properly be considered in making such a comparison, it is sometimes sufficient to warrant the installation of transformers or motor-generator sets for the purchase of part of the power requirements.

A typical case of this sort was described in the leading article of the December 22 issue, where an impartial study of actual conditions with the co-operation of the engineer, resulted in the purchase of power in excess of that capable of being generated from the heating steam. In this case the fuel saving alone would not have warranted the change, but labor savings were enough to swing the balance.

There is but one safe position for the engineer to take in matters of this kind. He must actively seek that method of operation which will give service of the required quantity and quality at the lowest over-all cost. He must stand prepared to rectify by careful analysis and indisputable logic any distortions of the truth, whether they seem to favor one method of operation or another. The engineer who proceeds on this sound principle is building a foundation of confidence and self respect that will stand him in good stead in the coming days of increasingly intelligent management.

A bill has been introduced in the Senate aimed to ascertain information concerning profits in coal mining through the medium of tax returns. The coal industry is in bad repute with the public, and the best thing it could do would be to give out its figures on production costs voluntarily, through the medium of the Department of Commerce, and thus save itself from hostile legislation.

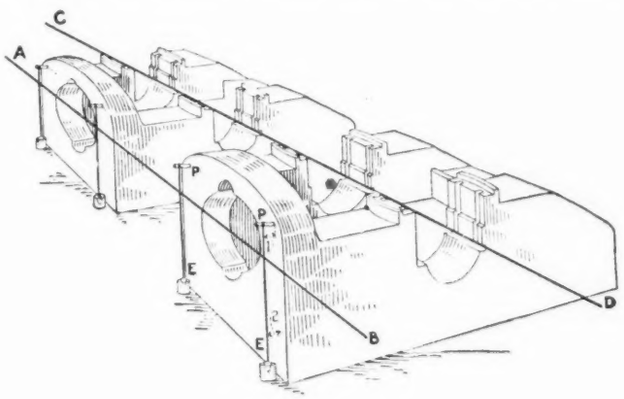
Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for November will be announced next month.

Aligning a Duplex Engine

In a certain plant which for obvious reasons will be left unnamed, the connecting-rod bearings and the main bearings persisted in running warm. Being sent to look into the matter, I found that if the bearings were loosened enough to prevent heating, the pounding became excessive. Apparently, the engine was out of alignment, and on taking the matter up with the erector I found that he had made no allowance for the expansion of the shaft. As the distance between the frames was 9 ft. and on the assumption that the running temperature of the bearings would be 120 deg. F., with an average temperature along the entire shaft of 80 deg. with a 60-deg. room temperature, the linear expansion would tend to push the frames apart and when combined with an initial misalignment, eventually caused the hot bearings.



Aligning lines used

It was decided to realign the frames, and the flywheel and shaft were removed. A line *CD* was run through the bearings parallel with the driven shaft. The ends were located on heavy cribbing, but to guard against shifting, an engineer's transit was held on the line and incidentally, the line was found to have moved ⅛ in. during the overhauling, owing to vibrations of the ground and building.

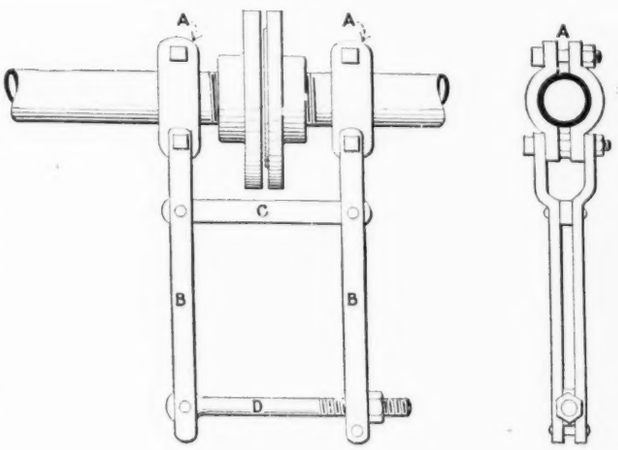
Pins *P* were placed in drilled holes in the face of the frames after the guide sections had been removed. Plumb lines were placed on the pins with the bobs resting in cans of oil *E*, to dampen all motion. The distances 1 and 2 were measured and the frames lifted until all eight measurements were identical. This made the frame faces square, insuring that the guides would be level. A second line *AB* was run parallel to *CB* and the frames shifted until the faces were at equal distances from the line. In arriving at the distance between the frames, they were set ⅛ in. farther than the blueprint showed, to take care of the shaft expansion. Upon replacing the guide sections, cylinders, etc., the engine was started without a pound, and no hot bearings showed up.

J. CASSIDAY.

Jersey City, N. J.

Separating Pipe Couplings to Insert Gaskets

In the overhauling of a milling company's power plant, it was necessary to renew all the leaking joints. These ranged from 3 to 6 in., and most of the joints were of the flange type. To open up the joint so as to remove the old gasket, much of which had to be chiseled off and to hold the two parts of the coupling open until the new gasket was inserted, a device as shown in the illustration was constructed.



Separating pipe flanges

Clips as shown at *A* were forged to fit the largest of the pipes to be opened, and when smaller pipes were met with, bushings made by splitting a short length of the intervening size of pipe were placed between the clips and the pipe.

For clamping these clips to the pipes, a bolt one inch longer than necessary to reach through the clips was

used, and on this bolt, one on each side of the clip, two of the arms *B* were bolted. To the clips on the opposite side of the coupling two more like arms were attached.

At a position where it would clear the largest of the couplings, a cross member *C* was attached. This was made of ½x3-in. iron-bar stock.

After clamping the clips to the pipes, the nut on the eyebolt was tightened, with the result that the coupling halves were forced apart and so held until the old gasket was removed and the new one fitted to place.

Rogers, Neb. WENDELL MITCHELL.

Why Induction Motor Failed to Start

Two 7½-hp. 220-volt three-phase 60-cycle squirrel-cage motors were installed in a grain elevator, each equipped with a starting compenator having both overload relays and an undervoltage release. Current for

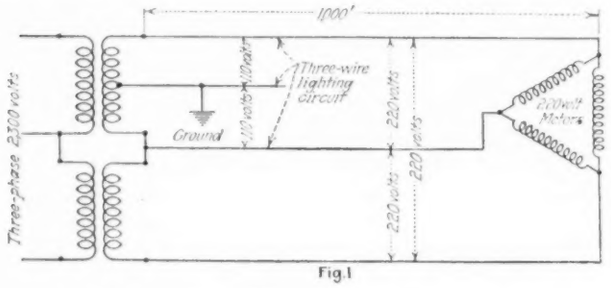


Fig. 1

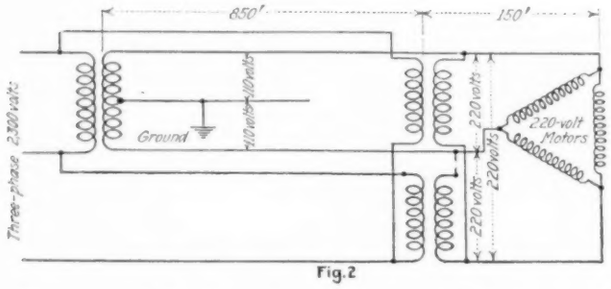


Fig. 2

Figs. 1 and 2—Transformer connection before and after the change was made

these motors was supplied over No. 6 copper wire from two transformers connected open-delta and located about 1,000 ft. distant. One of the transformers also supplied the lighting load in that vicinity and had its neutral wire grounded, as in Fig. 1.

When these motors were connected for service after standing unused for a considerable period, the owner complained that they started up slowly and that he could not run both at the same time. A voltmeter, connected across the switch near the motors, showed a voltage drop of about 25 volts when one motor was started and a drop of about 8 volts after it came up to speed and was carrying its normal load. But when the second motor was started with the first in operation, the voltage dropped to about 160 and the first motor immediately tripped off the circuit.

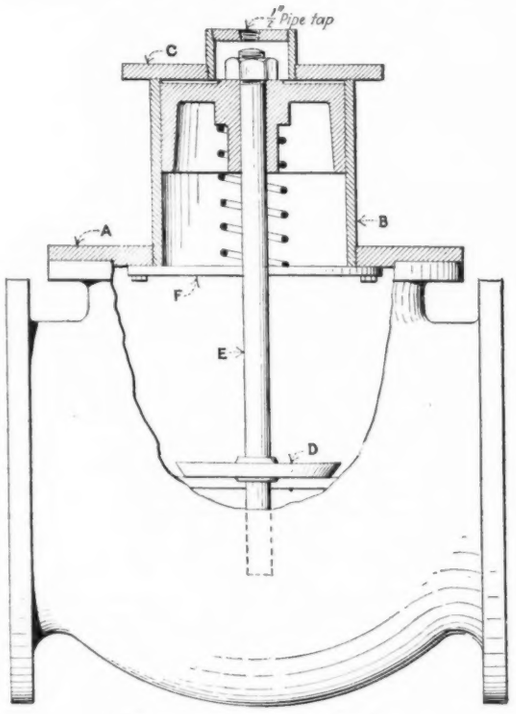
Rough calculations showing that the loss in the 1,000-ft. circuit of No. 6 copper wire was excessive on starting. I concluded without further investigation, that the undervoltage release was disconnecting the first motor when an attempt was made to start the second. To eliminate the greater part of the line loss, one of the two old transformers was moved and a new one was located about 150 ft. from the motors, and the three transformers connected closed delta, leaving the other old transformer in its original location, as in Fig. 2. After this was done, an attempt to start the motors showed the conditions to be practically the same as they were before the change in the line and transformers was made.

With one motor running, I watched its protective devices while an attempt was made to start the other motor, and found that instead of the undervoltage release, it was one of the overload relays that was operating to trip off the motor. Tests revealed that one wire from each compensator to its motor was grounded and creating a fairly low-resistance short-circuit on one phase when either motor was operating and the other was started. Also, since one transformer supplying these motors was connected with a grounded neutral, a current limited by the resistance between the transformer and the motor ground connections was flowing anytime either motor was in operation alone. By a coincidence, in making the tests with the voltmeter, I had tested across the phase that was shorted through the two grounds in the motor wiring. With these grounds cleared, the motors operated satisfactorily and both could be started simultaneously, although this will not be required in service.

Clayton, N. M. J. H. BENDER.

Making an Unloader for an Air Compressor

I had occasion to install an extra compressor in a system that was operated at 30-lb. pressure. This



Home-made air unloader

compressor had been out of service for some long time, and when we came to install it, the unloader was missing. Owing to the length of time required to get one from the factory, something had to be done immediately,

for the production department insisted that they must have more air. So I decided that an unloader must be made.

A 6-in. globe-valve body was used as the casing, and the top was bored out to accommodate a flange *A* turned to push fit. Into the flange a section of 5-in. extra-heavy pipe *B* was screwed to act as a cylinder. This was well peened into place, so as to be a tight fit. The other end of the pipe was screwed and peened into a 5-in. extra-heavy flange *C*. The whole was then put into a lathe and a light cut taken off the inside of the pipe, giving the cylinder a bore of 5.125 in. For the cylinder head I took a 2-in. nipple 2 in. long and screwed it into the flange *C*. This completed the cylinder except for welding a ⅜-in. plate disk in the top of the nipple and drilling and tapping it to take the ½-in. line from the compressor.

For the valve *D* and spindle *E* I used a piece of cold-rolled drill rod turned to ¾ in. diameter, with a ⅞-in. circular plate *D* welded to it. The other end was threaded to take a ⅜-in. nut. The piston was turned up from an old pump piston to a diameter of 5.12 in. After these parts had been assembled on the rod, the whole was turned up in one piece so that the piston and valve were concentric on the rod.

The spring, which was made from No. 10 spring wire, was slipped on the rod, the piston replaced, and a bottom plate *F* made of ¼-in. plate, 7 in. in diameter with a slotted hole so that it could be installed without pulling the piston off. The original valve seat was bored to take the new valve, care being taken that the seat was concentric with the rest of the valve and piston.

From the moment that the unloader was installed, it worked perfectly, and with a little adjustment unloaded at 30 lb. In fact, so accurate was its action that we cancelled the order for the regular unloader and used this as a permanent measure, instead of a temporary expedient to help out of a tight corner.

I did not keep an accurate cost of the work, but it was not more than 50 per cent of the cost of a standard make and every bit as efficient, besides being an interesting experiment of what can be done when put to a test.

MAURICE C. COCKSHOTT.

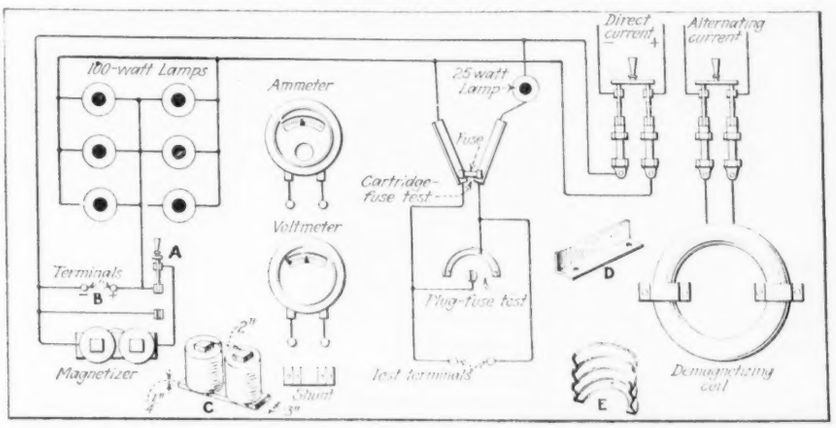
Hollywood, Calif.

A Handy Test Board

There are as many arrangements of electrical test boards as there are men who have made them. The design is influenced largely by local conditions, the pet idea of the designer and the material available to do the job with. The one shown in the figure has probably been subjected to all these influences, but I have found it convenient and practically unlimited in its uses.

With the single-pole knife switch *A* open, the bank of 100-watt lamps may be used for supplying current to an armature on induction-motor winding for testing, by connecting to the terminals *B*. Small storage batteries may also be charged from these terminals as well as used for operating small series motors during testing, the speed of the motor being adjusted by the number of lamps in circuit. With the switch *A* closed to the up position, the magnetizer is connected in series with the lamps. This magnetizer is made from a piece of ¼x3-in. iron with two short ¾-in. bolts threaded into it, which serve as the cores for the coils. Each coil is wound with 450 turns of No. 16 double-cotton-covered wire, or a total of 900 turns on the two coils. These magnets were used to remagnetize the magnets on the magnetos. With the switch *A* closed to the down position, the lamps will burn all the time.

The ammeter without the shunt is for testing direct-current armature and induction-motor windings. It can be connected to the shunt and used for measuring the load on a direct-current motor, or to check up on



Equipment and connections for test board

the current taken by a storage battery when charging, or any other occasion when it is desirable to check up on the current taken by a piece of equipment. The voltmeter comes in handy for checking the voltage drop across the field coils of direct-current machines, obtaining battery voltage and the like.

The cartridge fuse tester is made of two pieces of copper bent to form an angle, as shown at *D*. These are placed at an angle to each other on the board so as to be near together at the bottom for testing small fuses and separated farther at the top for testing large fuses. When the fuse is placed between the two angles, as in the figure, it is in series with the lamp, which will light if the fuse is intact.

For testing plug fuses, a half-section of a fuse receptacle *E* is fastened to the board and connected into one side of the circuit as indicated. A machine screw is fastened in the board to take the place of the center contact of the receptacle, and this is connected to the opposite side of the line from the receptacle. With this arrangement the fuse does not have to be screwed into the receptacle to make a test. Leads taken from the test terminals may be used for making lamp tests of all kinds, as the 25-watt lamp is connected in circuit.

Around the plant tools and watches and other devices are likely to become magnetized, and to provide a convenient means for removing the magnetism a field coil from an old direct-current machine was mounted as shown on the right-hand end of the board, and was connected to the alternating-current supply in the plant.

When such devices as are on this board are available in form for convenient use, the number of uses that will be found for them is surprising. The board has saved many times its cost on more than one occasion.

Philadelphia, Pa. S. O. MILLS.

Comments from Readers

Dressing for Leather Belts

On page 810 of the Nov. 24 issue Maurice C. Cockshott says:

The only lubricant needed is a dressing of neatsfoot oil on the surface away from the pulley surface. This is to take care of the friction evolved from the constant motion of the molecules of leather working against one another.

Every once in a while articles appear recommending the use of neatsfoot oil on belts, and as a result many users of leather belts now believe that neatsfoot oil is a good dressing. In the same way castor oil is often recommended. I wish to point out here that neatsfoot oil, which is an animal substance, should not be used because it will do more harm than good.

Any user of leather belting can make a test for himself by applying neatsfoot oil to a short piece of belting, applying enough oil so that it will penetrate into the belt. The belt will soon be found to be flabby and soft and to stretch easily. If that were all, it would not be so bad, but the worst feature is that presently a rotting process will begin and the leather fibers will be harmed. As a result the life of the belt will be materially shortened.

Instead of using neatsfoot oil, castor oil, boiled linseed oil, soap, tallow, and other similar harmful substances, I would recommend the use of a high-grade dressing that does not contain any harmful ingredients. A good dressing will contain elements that are preservatives and that add to the life of the belts rather than shorten it.

The foregoing is not alone the result of my own personal experience and observations, but is to be found in the statements issued by prominent chemists and big users of belting. W. F. SCHAPHORST.

Newark, N. J.

Writing Yourself to the Fore—How Can It Be Done?

An editorial in the Nov. 17 issue of *Power* advises engineers to write themselves to the fore. I should like to know how this can be done under the restrictions that confront the average engineer. To put it in another way, how may he write himself to the fore and continue to hold his job?

Most operating or designing engineers are in daily contact with all sorts of problems, and if descriptions of many of the solutions were published, they would be of great practical benefit to the profession at large. In some cases the engineers may not feel equal to the task of preparing an article for publication or he may be so busy he cannot afford the time, but in the majority of cases it is my opinion, based on experience and observation, that a very effective muzzle has been provided by others. Most industrial or engineering organizations have a rule that any employee writing for the press must have his manuscript approved by some official before publication.

Theoretically, it is merely a form to prevent misinformation reaching the public, but, practically, a subordinate who inclines toward literature soon finds it advisable to use his time for other purposes. Few men care to risk their positions for what self-advertising they might get from ignoring the censor. The high official is not the only one to be blamed. Just as often the head of a department is responsible for the blight, since the possibility that those higher up may see the rays from the candle of a possible successor is always with him and he acts accordingly.

If the censorship restrained the production of articles technically incorrect or of malicious intent, there could be no just criticism, but to restrain a competent engineer who has carried out some difficult piece of work and who knows his subject thoroughly, from giving others the benefit of his experience seems far-fetched so long as the interests of his employers are protected.

It is not only the written word that is muzzled, but the spoken as well. One of the most disheartening things about the engineering profession is to attend a society meeting and listen to what is almost a straight selling talk on a given subject, as void of real information as possible to make it, when in the audience are men who could give a much more interesting talk based on actual contact with the subject under discussion, yet are restrained from all except generalities by the wishes of their employers.

For example, the superintendent of construction of a large hotel talked for an hour at a meeting where 90 per cent present were full-fledged engineers, and gave an interesting outline of how the work was carried out and the problems met with; but in only one case did he show by his slides or explanations how they were dealt with.

Again, assume someone writes an article relating to the design of brackets for supporting piping. That is good so far as it goes, but a few practical examples of how brackets were built to meet unusual conditions would be of ten times more actual worth to the engineer suddenly confronted with an awkward problem of a similar nature. C. M. DURGIN.

Edgewood, N. J.

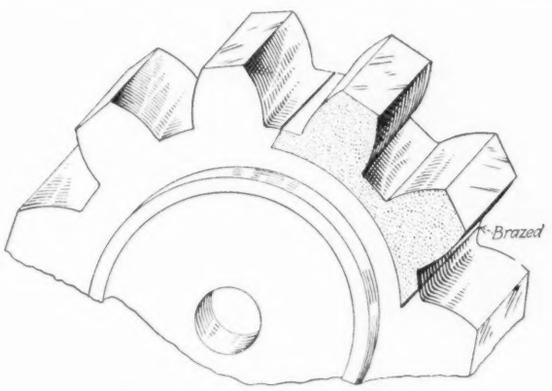
Emergency Repair of Castings by Cast-Iron Brazing

I read, with interest, the article by P. A. Spaulding in the Oct. 20 issue, because I have had considerable experience in repairing broken and fractured cast-iron parts. As the modern method of repairing broken cast-iron parts with the oxyacetylene torch and bronze is not so well known among power-plant mechanics and engineers as it ought to be, a few further notes may be of interest.

It is well known that before the oxyacetylene torch came into general use, large numbers of broken and fractured cast-iron parts, such as gear wheels, pulleys, flywheels, pump castings, pipe fittings, etc., were taken

to the junk pile and new ones substituted. Naturally, this occasioned a big loss to power-plant owners. Now oxyacetylene welding and brazing methods are employed to restore them, and a great saving is thus effected.

To mechanics unacquainted with the oxyacetylene torch, the welding of cast iron appears to be more difficult to accomplish than the welding of wrought iron or mild steel; but such is not the case. In fact, cast iron is the easiest metal to weld. In the welding of cast iron, a filler rod having a high percentage of manganese should be avoided for the same reason as that which makes its employment so necessary in the case of hard steel. Cast iron contains carbon both in a free and a combined state, according to the nature of the iron. Where the percentage of carbon exists in a free state, the cast iron is known as gray iron, and this is the iron most commonly used. Where, however, the carbon content of the cast iron exists in a combined state, the cast iron is known as white iron. Cast iron also contains



New teeth fitted to old gear

varying proportions of manganese and silicon, and the presence of these has a great bearing on the ultimate nature and quality of the cast iron.

In welding cast iron with the oxyacetylene torch, a flux is used for breaking up the oxide of iron which forms as a slag on the surface. Equal parts of carbonate and bicarbonate of soda make a useful mixture to use as a flux. Ferrosilicon rods are used as filling material, which contains approximately 3 to 3.5 per cent silicon, and this replaces or can replace any loss of silicon.

In welding cast-iron parts, the edges should be beveled when the thickness exceeds $\frac{1}{8}$ in., so as to enable the welding to penetrate the entire thickness of the metal. Workers who attempt to effect welds on cast-iron parts above $\frac{3}{16}$ in. in thickness, without beveling, invariably obtain poor results, as it is exceedingly difficult to get uniform and thorough penetration. When welds are required in castings where the casting is only cracked and not broken completely, the beveling can usually be done satisfactorily by means of a hand grinder. The edges to be welded and the areas near the weld joint must be perfectly cleansed. Scale, rust, grease and foreign matter will contaminate the weld, and such inclusions will necessarily weaken it or make it hard. Impurities may also make the cast iron porous and spongy owing to the liberation of gas.

If suitable precautions are not taken to minimize the strain or tension on the cast-iron weld after it has cooled down, fracture may occur. How this may be done most effectively depends on the nature of the job and the extent of the fracture. In some cases the best method to adopt is to put the weld under compression during the actual welding process. The cooling and consequent contraction of the metal causes a compression and produces a tendency toward a tension, and thus a couple is established.

In the case of a simple fracture, for example, the casting should be entirely heated to a dull red, when the welding should be expeditiously performed, after which the casting should again be heated uniformly and allowed gradually to cool. A second method is to heat the casting to a dull red, so that the consequent expansion almost closes the fracture by compression. The casting is then allowed to cool, so that the fracture becomes slightly larger than formerly, after which it is immediately welded and then transferred to the furnace to be uniformly heated throughout, and then allowed to cool gradually.

In the case of a large crack or fracture it is usually best to weld at two operations. Begin at the middle of the fracture and weld to one end, then allow it to cool down. Afterward again start at the middle and work to the other end, then anneal the whole job as previously mentioned. Subsequent fractures are less likely to occur in cast-iron products if this method is put into practice. Never attempt to re-weld cast-iron parts that have been previously welded without first cutting away all the old metal.

As mentioned in the article referred to, the brazing of cast iron is a relatively new application of the oxyacetylene torch. The advantage of brazing broken or fractured cast iron with bronze under the torch flame are said to be: (1) Its rapidity; (2) the small amount of preheating necessary; (3) increased ductility; (4) less contraction stresses; (5) greater strength and rigidity.

In addition to the modern practice of using a bronze filler with the oxyacetylene torch for repairing broken or fractured cast-iron parts, monel-metal rods are also extensively used, as experience has shown that monel metal penetrates the cast iron, produces a homogeneous joint and at the same time produces a joint suitable for machining.

The accompanying sketch shows a repaired gear wheel recently brazed in our power plant. A piece of blank metal was fitted into a dovetailed groove filed in the broken portion of wheel. The teeth were roughly sawn to shape and then filed to the shape of the other teeth. This was done by cutting a sheet-steel templet to the form of the tooth and scribing its shape and position on the blank. Care was taken to insure that the teeth were in pitch.

When properly fitted and the joints thoroughly cleaned, such a repair may easily be brazed with bronze, monel metal or ordinary brazing metal. Equal parts of calcined borax and boric acid can be used as a flux. The work should be heated slowly to a cherry red, the brazing flux and metal applied and the heat maintained until the brazing metal has flowed through the joint. Allow the job to cool slowly, as rapid chilling is often injurious to castings. Steel gears may be economically repaired in a similar manner. In conclusion it might be well to mention that it is customary in repairing broken cast-iron parts with the oxyacetylene torch and bronze filler to apply the term "welding." In the writer's opinion such a process is really brazing, not welding.

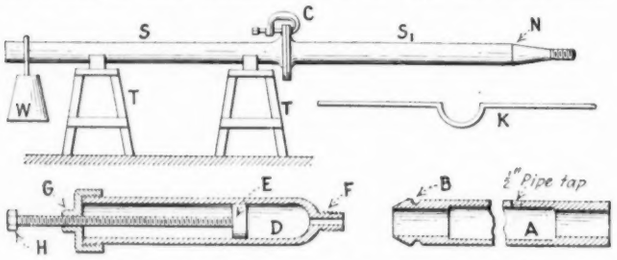
E. ANDREWS.

Manchester, Eng.

Shrinking Sleeves on Shafts

In the Oct. 20 issue of *Power* there appeared a contribution on shrinking a long sleeve on a shaft. This was of special interest to me, since I have had some experience on propeller shafts and quite understand the nervous strain on those unaccustomed to such work. Perhaps the methods I have used will be of interest and lead to other suggestions helpful to those who are up against it on a strange job.

The illustration outlines one useful rig for supporting the shaft. We were fortunate in always having a rough-turned or an old shaft in stock, which was supported on strong wood trestles *TT* and wood V-blocks. Any weight *W* was suspended at the end. The shaft S_1, over which the sleeve was to be shrunk, was then placed as shown and secured by three or four clamps *C*. The sleeve *A* was supported on wood trestles and iron V-blocks at the end of the shaft so as to be handy for a straight lift. The sleeve was counterbored ¼ in. larger for a length that would allow it to grip the shaft and



Method of shrinking a sleeve on a shaft

be solid not only in the packing box and neck bushing at the inner end, but also in the stern bushing at the outer end. A hole was drilled and tapped with ½-in. pipe thread in the counterbore. The allowance we made for shrinkage was 0.001 in. for each inch in diameter of the shaft, and the sleeve was heated until it expanded 0.001 in. above size for each 1½ in. in diameter of the shaft. Thus, for a 12-in. shaft the sleeve would be bored 12 in. minus 0.012 in. and would be heated to 12.008 in. Internal allowance gages were made for trial during heating, which was done with a large kerosene blow-torch. Everything being ready, the torch was set alight and burned with a hot clean flame. One end of the sleeve was stopped with a plate and sheet of asbestos millboard, and the torch was placed on a support so that the flame carried along the inside of the sleeve. The time occupied in heating a sleeve 13¼ in. outside diameter and 12 in. inside diameter and 18 ft. in length, was from 45 to 50 min. As the heating proceeded, helpers stood ready with carrying bars shown in the sketch at *K*, with another helper ready to take the torch to one side. At a given signal the torch was moved away, the sleeve lifted and carried to the shaft, another signal given and on went the sleeve. When the shaft had cooled down, it was put in the lathe to test for accuracy and to machine the sleeve to size.

Over a period of eighteen years I have never had a sleeve seize before it was in place.

The sketch shows a force pump *D*, the end *F* being somewhat tapered and bored ⅜ in. through into the barrel. The over-all length of the pump barrel is 14 in., and it was made from 2-in. hexagon mild steel. The cover *G* is tapped ¾ in. to accommodate the screw to which a cupped leather piston *E* is attached. The force pump is used for filling the space between the shaft and the sleeve with a paste made by thinning red-lead putty with boiled linseed oil. The pump is screwed into the sleeve, and a charge of paste forced in. Considerable pressure should be applied to the pump to force the paste into any porous places that may be in the metal. A brass plug is made and screwed tight into the filling hole and the shaft is then protected from the corrosive action set up by the two different metals in sea water. In the sketch a groove *B* is shown in the sleeve *A*. This is turned in the sleeve at the coupling end and tends to drain off any sea water that may leak in through the packing, thus preserving the inner end of the shaft. The outer end of the shaft at *N* is protected by fitting a rubber ring of square section smeared on the inside with red-lead putty. The thickness of the ring must be such as to allow it to be squeezed when the propeller is tightened up on the shaft.

If there is not the convenience of a rig-up as shown, I would suggest bolting the shaft in a horizontal position to any suitable machine or even a supporting column for a smaller shaft. Some ship owners prefer their propeller-shaft sleeves fitted on in two pieces. In these cases the shaft is stepped and one end of the two sleeves made to fit over the other a distance of about 1 in.; the joint is then run up with solder while still hot. Brass dowel pins are screwed into each half sleeve, as an extra precaution to keep the sleeve tight to the shaft.

FREDERICK PREVETTE.

Toronto, Canada.

Starting Torque of Motor-Driven Plunger Pumps

In the Sept. 8 issue of *Power* it was stated that when plunger pumps had tightly packed stuffing boxes and sliding pistons, the initial breakaway torque required of a motor for starting may equal 125 to 250 per cent of normal full-load torque. The statement was also made that large reciprocating pumps are frequently equipped with a bypass, which relieves the pressure during the starting period so as to decrease the starting torque required from the driving motor.

I have had charge of the installation of a number of high-pressure pumps, and the experience in one plant is especially applicable to this question of starting. These pumps were driven by 300-hp. 2,200-volt 72-r.p.m. motors. When a motor was started with the pump bypass valve open, the maximum current shown by the ammeter was approximately 50 amperes. The static head on these pumps is 1,100 lb. per sq.in., and the water they were pumping was from an iron-ore mine carrying a great amount of gritty matter. To close the bypass valve against this great pressure was very hard on the valve, and it was possible to keep them tight only a short time.

Later, the hydraulic engineer and the chief electrician got together and decided to start the pumps with the bypass valve closed. When starting in this way, the motor required 100 amperes, but as the starting period is only about 30 sec. no harm was done. The 100 amperes were required only for 4 or 5 sec. while the controller was being moved over the last two or three contacts.

These pumps have been in use about three years, and this method of operating has done no harm.

Norway, Mich. THOMAS PASCOE.

Questions and Answers

Conducted by

Franklin Van Winkle

Lubricating Oil For Ammonia Compressor

Will ordinary engine oil be suitable for use in an ammonia compressor? What are the factors to be considered? P. R.

In the selection of an oil for use in the ammonia compressor it is important that the choice be made with a view to securing one with a high flash-point, great viscosity and low congealing point. The best is none too good as to the points mentioned, and price should not enter into the question at all, as the effect caused by the use of an inferior grade of oil will offset the difference in price many times over.

A good grade paraffin oil, with the wax as completely removed as possible, will make a good ice-machine oil. The more paraffin wax the refinery removes from the paraffin oil, the lower will be the congealing point, which ranges somewhere around 15 to 18 deg. F. below zero.

The engineer should never under any circumstances allow engine oil to be used in the compressor or on the compressor piston rod.

As a guide to the engineer who is not familiar with the physical properties of ice-machine oils, the table below gives the essential properties of some good oils.

PHYSICAL TESTS OF OILS

Kind	Specific Gravity	Viscosity	Flash Deg. F.	Fire, Deg. F.	Congealing Point, Deg. F.
Arctic ice-machine oil..	0.8920	3.93	372	399	—19
Ice machine.....	0.8746	3.93	368	392	—24
Ice machine.....	0.8912	3.225	320	360	—20
	0.9258	4.18	330	360	—20

Will Increased Speed Reduce Steam Consumption?

I have a 12½x24¾x36-in. cross-compound Corliss engine operating under 165 lb. steam pressure and turning at 100 r.p.m. If the speed is increased to 115 r.p.m. without a change in the load, will the steam consumption be increased or decreased? J. G.

Before answering, it is necessary to define what is meant by load. This is used both as the brake horsepower output and as the torque or pull at the belt wheel.

Assume first that the horsepower output is to remain constant. In this case, inasmuch as the engine speed is to be increased, the torque at the belt wheel will be decreased as is evidenced from the formula for horsepower,

$$HP = \frac{2\pi FRN}{33{,}000}$$

where R = wheel radius in feet, F = belt pull in pounds N = r.p.m., and $\pi = 3.1416$.

If the revolutions per minute N are increased, the torque FR must be decreased to maintain a constant horsepower. If the driven lineshaft is to be kept at the same speed, the driven pulley must be made larger.

It is well to bear in mind that most driven machines require a certain torque, and usually this torque is constant regardless of the speed. As an example, a grain elevator requires a certain pull on the head pulley regardless of the elevator speed per minute.

The formula for the horsepower developed within the cylinder is:

$$I.H.P. = \frac{2PLAN}{33{,}000}$$

where P = mean effective pressure, L = stroke length in feet, A = piston area in sq.in., and N = r.p.m.

If the indicated or developed horsepower is to be constant, the mean effective pressure P must be less at the higher revolutions per minute. Inasmuch as the engine friction is but a small part of the developed horsepower, for practical purposes one can assume that the brake horsepower increases and decreases with the indicated horsepower. To obtain a lower mean effective pressure with the same back pressure, the engine must cut off earlier. The indicator diagrams sent show a total expansion ratio of approximately 10. In the usual design a ratio of 12 will result in a lower steam consumption. Just how much this decrease will be depends upon the engine design.

If the torque or belt pull is to remain constant, increasing the speed will increase the horsepower but the mean effective pressure and cutoff ratio will be unchanged, while the increased steam consumption will be in direct proportion to increase in horsepower.

Shutting Down a Turbine

How should one go about shutting down a small noncondensing steam turbine? M. S.

After taking off the load it is customary to trip the emergency valve by hand to make sure it is operating. In case the main throttling valves do not close tightly it is of course necessary to throttle by hand before the load is taken off to prevent running away. After the machine has been shut down, the drains should be opened to the casing or cylinder in order to prevent water accumulating under the rotor, which would very shortly make trouble by causing it to rust and become unbalanced. If the machines are shut down for more than one day it is customary to close the steam off at the header and open the drains at the throttle so that no pressure will exist at the throttle valve. This will prevent water or steam leaking through the throttle valve and affecting the rotor. The cooling water should then be turned off and also the exhaust valve if it is customary in the station.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications, and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Using Water to Pump Water

WATER can be made to pump itself or, to be more precise, *part* of itself! One of the best-known examples is the hydraulic ram. In this device the overflow from a spring or other source of water under slight head is allowed to discharge to waste through a length of comparatively large piping.

When a certain velocity of flow is reached, the water automatically closes a check valve, shutting off the waste outlet of this pipe. The result is an artificially produced water hammer which builds up a relatively high pressure. This forces a small amount of water through another check valve to an air-cushioned chamber from which water may be piped to a point considerably higher than the spring. The operation of the hydraulic ram involves no violation of the law of conservation of energy. On the contrary only a small part of the available energy of the falling water is recovered.

Ram Has Low Efficiency

If the fall of water in the main ram pipe were 10 ft., for example, and the head pumped against were 100 ft., a 100 per cent efficient ram would pump one pound of water for every ten pounds wasted. In practice but a small fraction of this amount would be delivered because of the inherent inefficiency of the hydraulic ram.

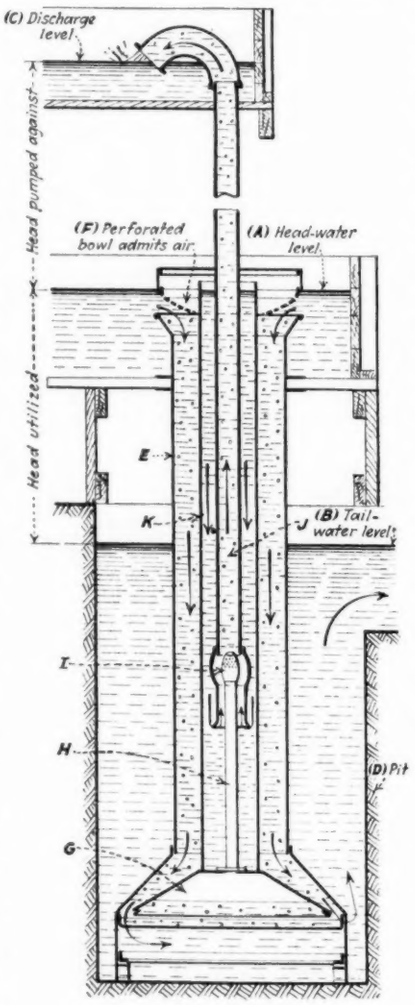
There are certain applications where the low efficiency is of no importance. For example, a farmer might properly use a hydraulic ram to pump small amounts of drinking water from a near-by spring with a sufficiently large flow.

Engineers look upon the hydraulic ram as little more than a toy, its applicability for engineering purposes being extremely limited. There are, however, other methods of making water pump water which have engineering importance. Hydro-electric power is sometimes used to operate motor-driven pumps. In this way a low-head development may supply a city with water under high pressure.

Then there are cases intermediate between the extremes represented by the hydraulic ram on one hand and the motor-driven pump operated by hydro-electric power on the other. It frequently happens, particularly in isolated irrigation projects, that a fair quantity of water must be pumped a few feet above the upper level of a small waterfall, but the nature of the service does not warrant the installation of expensive machinery.

In such cases use may be made of a new type of apparatus of simple construction and without many parts and yet said to be capable of efficiencies as high as 50 per cent. Such a device is shown in Fig. 1, which is based on a sketch in the Nov. 21 issue of the French periodical *Genie Civil*.

The natural fall of the water is from head-water level *A* to tail-water level *B*. Water is to be pumped to discharge level *C*. To accomplish this the fall of water from *A* to *B* is utilized to compress air. This, in turn, is used to operate an "air lift" pumping water to *C*.



Novel air lift makes its own compressed air

A pit *D* is first excavated to a sufficient depth to produce the required effects. Then the tubes, etc., as shown, are installed.

The main flow of water is down through *E*. On entering *E* the water becomes mixed with air bubbles coming through the perforated bowl *F*. These bubbles pass down with the water and are compressed in proportion to the depth below *A*. Before passing to the tailrace *B*, the water releases most of the air under pressure to the hollow cone *G*. This air passes up through *H* to the perforated head *I*, from which it bubbles into the water in *J*.

From here on the apparatus is a straight air lift. Water entering the top of tube *K* from the head-water level (through a connection not shown) passes down around *J* and up through it to a higher level, since the solid water outside *J* weighs more per cubic foot than the air-filled water within. As a result water is pumped to the discharge level *C*.

While the fundamental principle of the air lift is easily understood, the design of air-lift apparatus for a given capacity and maximum efficiency under given conditions requires specialized knowledge. This is even more true of the apparatus shown because this is an air lift plus a hydraulic air pump.

The apparatus just described is of the continuous type and, as will be noted, has no valves or moving parts. Other types of water-operated pumps run on an intermittent or alternating cycle.

One form, described in *Genie Civil* provides two chambers between head-water and tail-water levels. By a mechanically operated valve water is admitted first to one chamber and then to the other, compressing air in the process. The chamber not being filled drains to the tail-water level, producing a suction. The resulting pressure and suction are transmitted to a series of tanks with automatic check valves so arranged that the air forces or lifts water from one tank to another by direct displacement. In this way water can be pumped considerably above the head-water level.

Discussing the relative advantages of generating process steam at high and low pressures, it is common practice to compare the total heats of steam at the two pressures. This has less significance than might appear at first sight. If saturated process steam is now generated at 10 lb. gage the total heat is 1,160 B.t.u. For generation at 100 lb. gage the total heat is 1,189 B.t.u. It is a mistake to assume that this, of itself, means the consumption of slightly more fuel. The heat content per pound is not changed by passing steam through a reducing valve. Since 1,189 B.t.u. are available per lb. the reduced-pressure steam will be slightly superheated and it will require correspondingly less steam to do the work. In a case where the low-pressure steam must be superheated the initial high-pressure steam may be superheated a smaller amount to give the same heat content; none of this heat is lost in passing through the reducing valve. An engine removes some heat equal to about 0.4 lb. coal per kw.-hr.

The Laclede Gas Building Explosion

By F. H. Schubert

ON OCT. 8, 1925, the eleven-story office building of the Laclede Gas Light Co. at the northeast corner of Eleventh and Olive Sts., St. Louis, Mo., was rocked by a terrific explosion, resulting in fire, in which four people lost their lives and fifty odd were injured.

The newspapers immediately ascribed the cause to an explosion of ammonia tanks, although in succeeding editions they changed their views and made statements that the disaster appeared to have been caused by an explosion of gas.

The directors of the St. Louis Refrigerating & Cold Storage Co., which sells refrigeration to the building, retained a board of three independent engineers—George E. Wells, Victor J. Azbe and Edward B. Fay—to make a survey of the situation.

Testimony at the Coroner's Inquest

Edward R. Christopher, Building Commissioner of the City of St. Louis, testifying at the coroner's inquiry into the explosion, stated that he had thoroughly investigated the situation and had decided that the explosion could not have occurred from ammonia, for the reason that there was only a ½-in. supply line in the building. In fact, the cooling coils in which the ammonia pipes rest were still intact, had not exploded. The ammonia pipe supplying the tank passed through the room in which the explosion occurred, but the break in the ammonia pipe was not in that room, but in the adjoining room, and was caused by the falling of the brick walls through which the pipe passed.

The St. Louis Fire Prevention Bureau, George A. Madison, chief inspector, after covering the details of construction, exposure, occupancy and weather conditions, stated that a heavy leakage of gas had been noted and reported by employees on various floors in the vicinity of the pipe shaft several minutes before the explosion occurred, and that the engineer and his assistants had gone to investigate when the explosion occurred, causing their death.

Faulty Pipe Installation

Careful investigation had been made by inspectors from this Bureau before any débris or material had been removed, and it was their opinion that the hangers supporting the long six-inch gas main passing through the stock-room gave way, causing the pipe to sag and fall, breaking the flanged union joining two 18-ft. lengths and permitting a large volume of gas to escape.

This pipe extends from the meter room through the stockroom to the gas-fired demonstration boilers in the west end of the basement, a distance of about 65 ft. with two right-angle turns. It was suspended under the metal lath and plaster ceiling, while other piping originally installed was placed under the floor above the ceiling.

The investigation disclosed only two hanger supports for this pipe, these hangers consisting of ⅝-in. rods with turnbuckles, the lower end of the rods being attached to clamps around the pipe. The upper ends were not clamped to the lower flange of the floor I-beams as they should be for secure support, but were fastened by expansion bolts to the concrete protection around the beams, the bolts being inserted in the concrete on the side of the beams about 3 in. above the lower edge. At one of the hangers this edge of the concrete had been broken off, releasing the bolt and hanger. The upper end of the rod and turnbuckle of the other hanger was still attached to the floor beam and the lower end of the rod attached to the clamp on the fallen pipe. Though parted, the threads were not stripped, and from appearances this supporting hanger never had been joined in the turnbuckle and consequently had afforded no support.

The cause of the ignition of the escaping gas cannot be determined. There was fire under the steam boilers, but they are located in a separate room some distance from where the explosion occurred. The gas-fired demonstration boilers were not being operated at the time. No evidence was found to substantiate reports that the explosion was caused by steam or ammonia.

Recommends That Pipes Be Placed Underground

Consideration of the circumstances in connection with this disaster, resulting in heavy loss of life and personal injury, induced the Bureau to recommend that long runs of large gas mains within buildings be placed underground and not be suspended from ceilings by doubtful supports. Underwriters approved gas shutoff pull boxes should be conveniently located outside buildings, for use in emergency cases to shut off the gas supply. Pipe shafts extending and forming a flue through high buildings should be blocked at each floor level. If the pipe shaft in this building had been so blocked, it is probable that the effects of the explosion and fire would have been confined mainly to the basement and first story.

The report made by the board of independent engineers under date of Oct. 15 stated that it was apparent that the break in the ammonia lines was caused by an external force, probably the wreckage of the first interior wall, which was caused by the explosion occurring in the northern portion of the basement. The elbow of the 1¼-in. ammonia pipe was broken completely in two, which would indicate violent external force. The break was a clean one and no defect was observed.

Ammonia System Not Responsible

It was the committee's conclusion that the break in the ammonia lines had been caused by an external force, such as the collapsing of the interior wall which was expelled in a southerly direction by an explosion occurring in the adjacent room located in the north portion of the basement. The break of the pipes was, therefore, outside the room in which the explosion occurred.

The ammonia pressure was very low compared with the safe working pressure of the pipes utilized for ammonia service. In fact, safe working pressure was over 10 times the pressure that was carried in the pipes.

Engineering and Research*

By Milo S. Ketchum†

When Rankine was appointed to the chair of civil engineering at the University of Glasgow in 1885, he found a chair without a science. In a few years he developed the theory of applied mechanics and the theory of thermodynamics, and wrote books on civil engineering, applied mechanics, steam engines and machinery that were used as textbooks until recently and are still standard reference books.

Rankine found engineering a trade and made it a science. In addition to a vigorous mind, he had a thorough training in mathematics, physics and the sciences, and an extensive experience as an engineer. Many men before his time had had the training to solve the problems had they been proposed to them, and many could see part of a problem, but did not have sufficient training to solve it or to explain it to others. Rankine had both the ability to see the problems and the training to solve them. His work is the best evidence of the fact that an engineer cannot see those things that he cannot understand, and that in the development and growth of applied science, theory and practice must go hand in hand, the one helping and assisting the other.

There is no longer any conflict between engineering theory and engineering practice. It is now universally recognized that a satisfactory design can be evolved only after all the theoretical and practical considerations have been taken into account. The engineer is no longer satisfied with rule-of-thumb methods, which were formerly the basis of the art of engineering.

The growth of science is not spontaneous. Engineering science is dependent on well-directed effort and the expenditure of time and energy in research and construction. The difference between pure science and applied science is not one of method but of aim. The worker in pure science is not interested in the utility of the facts, but in developing the science. In applied science the engineer makes use of all the known facts and methods given him by pure science to obtain a solution of his problem. If known facts and methods are not sufficient to solve the problem, he must either make additional observations or develop new methods of analysis, or make an approximate solution until such time as more exact information is available. In any event he must obtain a solution.

Engineering is a progress, and engineering research is the foundation of engineering progress.

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*Extract from paper read before the School of Mines and Metallurgy, University of Missouri.

†Dean, college of engineering, University of Illinois.

Recent Publications

Zentrifugal-Ventilatoren (Centrifugal Ventilation Fans). By Erich Gronwald. Published by Julius Springer, Berlin, Germany, 1925. Cloth; 6x9 in.; 178 pages; numerous charts, illustrations and tables. Price, 12.60 gold marks.

Fan and ventilating experts who can read German will find this a good treatise on the fundamentals. The treatment is rational. The book is unusually complete in tables and diagrams covering the characteristics of dry and saturated air.

Fuel Economy and Smoke Prevention. By John B. C. Kershaw. Third edition, completely revised and rewritten. Published by D. Van Nostrand Company, 8 Warren Street, New York City; Cloth; 6 x 9 in.; 268 pages; 91 illustrations. Price $5 net.

While this book is, in a way, a third edition of "Smoke Prevention and Fuel Economy," which first appeared in 1904, the changes made since the second edition of 1911 are so thoroughgoing that it may be looked upon as practically a new book. The original book was written by Mr. Kershaw in collaboration with W. H. Booth, who recently died. Written and printed in Great Britain, this volume represents on the whole British practice rather than American; that is, the American reader turning to any section for practical information, will find there apparatus with which he is not familiar. For the operating man this is a disadvantage. On the other hand, the designer might profit by the study of foreign apparatus. It should not be assumed that the book is entirely British in point of view, as some effort has been made to include data from American sources. These data represent recent practice. Among the subjects covered are the constitution of coal, the preparation of coal, the selection of fuel and framing of contracts, the storage of coal, chemistry of combustion process, improved methods of burning fuel, pulverized liquid and gaseous fuels, control of the combustion process, foremost systems of boiler control, utilization of waste steam, legal aspects of smoke abatement, boilers and furnaces in recently erected large power stations, etc.

Six-Place Tables (Second Edition.)—By Edward S. Allen, Associate Professor of Mathematics, Iowa State College. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City, 1925. Black imitation leather; 4x7-in.; 144 pages. Price, $1.25.

This book, which will slip conveniently into the hip pocket and whose black cover will not easily soil, is a valuable compilation of tables frequently used by engineers. The first table covers squares and cubes, square and cube roots, circumferences, areas and reciprocals. Table II gives fifth roots and fifth powers over a convenient range, and Table III the circumferences and areas of circles from $\frac{1}{64}$ in. to 100 in.; the steps being $\frac{1}{64}$ in. Part I closes with a table of decimal equivalents. The tables in Part II include logarithms of numbers and of trigonometric functions. Other tables cover natural trigonometric functions, exponential and hyperbolic functions. In the back are listed a considerable number of trigonometric formulas and tables of integrals. The value of this pocket book is enhanced by the introduction, which gives an extensive discussion of logarithms, with practical examples of the use of the table. Some of these features were not contained in the first edition, which appeared in 1922.

Practical Marine Diesel Engineering. By Louis R. Ford. Published by Simmons-Boardman Publishing Co., New York City. Cloth; 6x9 in.; 506 pages, 264 illustrations. Price, $7.50.

Those who are at all interested in the Marine Diesel engine will find this volume filled with meaty material. The author has undertaken to lay down the general principles upon which all Diesels must operate, together with an outline of the characteristic details of the more important engines in service. It is unfortunate from an author's welfare that the art is advancing so rapidly, for it is impossible to assemble data and read the proof before much of the material no longer applies to the latest machines. In those portions devoted to operation, the author shows his familiarity with the practical problems facing the Diesel engines. The chief or assistant engineer of any motorship will find in the volume more than enough to repay the time taken in its study. Taken all in all, the author is to be congratulated upon producing a most readable and valuable treatise on the oil engines.

The Industrial Museum. By Charles R. Richards, director of The American Association of Museums. Published by the Macmillan Co., New York City, 1925. Cloth; 6½x9½ in.; 117 pages; 116 illustrations. Price, $3.

The establishment of industrial museums in America is the underlying motive for this book, which describes the four European industrial museums in Paris, London, Munich and Vienna. The illustrations give an illuminating idea of the exhibits contained and work being done in these museums. Chapter II is devoted to the Conservatoire des Arts et Metiers; Chapter III to the Science Museum; Chapter IV to the Deutsches Museum; and Chapter V to the Technical Museum, Vienna.

One chapter is devoted to industrial museums in America, in which costs are discussed and in which are outlined the requirements for such a museum in America. The National Society of Vocational Education in 1919 obtained from the General Education Board a grant that enabled it to make a survey of art in industry. This was published in 1922. After this was finished, the society decided to undertake a study of museums of industrial art abroad. The result of this study will be published in two volumes, the first of which is this, "The Industrial Museum."

Power Map of Virginia—The United States Geological Survey, co-operating with the Virginia Geological Survey, has just published and will supply for 50 cents a new edition of the map showing electric power stations and transmission lines used in public service in Virginia and the river-gaging stations maintained or proposed. The map has been prepared in connection with the work of collecting up-to-date statistics relating to the production of power at central stations and with a co-operative investigation of Virginia's water resources.

An Investigation of the Fatigue of Metals, Series of 1925, by H. F. Moore and T. M. Jasper. This is bulletin No. 152 of the Engineering Experiment Station of the University of Illinois in co-operation with the National Research Council, Engineering Foundation, General Electric Co., Allis-Chalmers Manufacturing Co., Copper and Brass Research Association and the Western Electric Co., and is published at the University of Illinois, Urbana, Ill., and costs 50 cents.

The Bennis Standard Evaporation Tables, compiled and calculated by G. A. Rossetti, is published by Edward Bennis & Co. Ltd., 28 Victoria St., London, S.W. 1, price 60 cents. These tables, based on Professor Callendar's data are intended for the rapid and accurate determination of boiler outputs, efficiencies, fuel consumption, etc.

Engineering and Research by Milo S. Ketchum. Published by the School of Mines and Metallurgy, University of Missouri, Rolla, Mo. This pamphlet gives the names, the institutions, societies, etc., engaged in engineering research.

Mechanical World Year Book for 1926—This is the thirty-ninth year for this publication, which is put out by Emmott & Co., Ltd., 65 King St., Manchester, England. It is cloth backed and costs 36 cents.

Annual Report of the Supervising Inspector General of the Steamboat Inspection Service for fiscal year ended June 30, 1925. Government Printing Office, Washington, D. C.

Annual Report of Chief of the Bureau of Engineering, 1925—Navy Department, Bureau of Engineering Government Printing Office, Washington, D. C.

Fifth Annual Report of the Federal Power Commission, Fiscal year June 30, 1925. Government Printing Office, Washington, D. C.

World Power Conference, English Section Meeting

The nations that are members of the World Power Conference have been invited to be represented at a sectional meeting in September of 1926, in connection with the International Waterways and Hydraulic Power Exhibition, England. The agenda includes discussion on the application of electricity to agriculture, the electrification of railways and the exchange of power between different countries.

Public Utility Rates Matter for State Courts First

There was introduced into the United States House of Representatives on Dec. 7, a bill, H.R. 3759, to amend Section 266 of the Judicial Code of the United States. The proposed amendment which is to be added at the end of the Section is: "*Provided*, that no action or proceeding relating to rates or other charges shall hereafter be brought in any court of the United States by any person or corporation engaged in the business of what is known as 'public utility' as defined herein, at law or in equity, unless such person or corporation has heretofore made an application to a state court having jurisdiction, and such state court has finally decided the issue involved, and no injunction shall be granted in any court of the United States to such person or corporation where the state court has jurisdiction in the premises."

The term public utility includes the telegraph, telephone, cable companies, wire or wireless, and gas and electricity for light, heat or power.

Tennessee River May Be Made Exempt from Water Power Act

An effort to take the Tennessee River out from under the Water Power Act is gathering momentum. Legislative steps already are being taken to that end.

Senator McKellar, of Tennessee, has accused the Corps of Engineers of improprieties in making public information as to the survey of the Tennessee River before submitting it to Congress. He also criticized the Chief of Engineers, on the floor of the Senate, for his refusal to postpone a local hearing at Chattanooga on Tennessee River applications.

Following Senator McKellar's comment in the Senate, Representative Dempsey in the House defended the action of the Corps of Engineers and put into the *Congressional Record* General Taylor's reply to Senator McKellar, which pointed out that the Chattanooga hearing was in accordance with the provisions of the Water Power Act. "Refusal to hold hearings," General Taylor said, "when the full requirements of the law have been met, as they were in this case, would deprive the applicant of his legal rights. I do not consider that I have such authority. Such a refusal, in effect, would nullify the provisions of the Federal Water Power Act. So long as the Water Power Act remains in force, as now worded, I must continue as I have in the past."

Canadian Plants Increase Capacity in 1925

The Canadian government has just issued its report on the Central Electric Station Industry for 1924. While there was no change in the number of plants, transmission and distribution lines were extended in every province. Many additions were made to existing power plants, especially in the hydraulic stations. Waterwheels increased 26 in number and 425,410 hp. in capacity; steam turbines and internal-combustion engines also increased both in number and capacity, and reciprocating engines showed reductions, the net increase in primary power of main plant equipment being 425,605 hp., and of auxiliary equipment, 18,530 hp.

Some of the larger additions made during the year were 120,000 hp. by the St. Maurice Power Co.; 22,600 hp. by the Montreal Light, Heat & Power Co.; 20,000 hp. by Quinze Power Co. in Quebec; 136,000 hp. in the Niagara plants; 6,600 hp. in the Central Ontario system and 25,000 hp. in the Cameron Falls plant on the Ontario Hydro Electric Power Commission, and 12,500 hp. by the Canadian Niagara Power Co. in Ontario. In Manitoba the Manitoba Power Co. put into operation 56,000 hp., and in British Columbia the East Kootenay Power Co. added 15,000 hp. to its Fernie plant.

The output was less than during 1923 in Nova Scotia, Saskatchewan, Alberta and in the Yukon, but the increase of 898,408,000 kw.-hr. in Quebec, 167,296,000 kw.-hr. in Ontario, 124,056,000 kw.-hr. in Manitoba and 30,849,000 kw.-hr. in British Columbia, with smaller increases in the other provinces, produced a net increase of 1,216,089,000 kw.-hr., or 15 per cent.

The total output of fuel stations was less by 8,695,000 kw.-hr., or 5.5 per cent. The hydro stations increased their production in every province, stations in Quebec leading with an increased output of 898,631,000 kw.-hr. The fuel power plants are almost as numerous as the hydraulic plants, and are used generally as lighting plants in small municipalities. Their output was 6 per cent of the total. The hydraulic power plants produced 94 per cent of the output of the industry.

Broad River Steam Plant To Add Another Unit

The second unit of 34,000 hp., consisting of a steam turbine and generator for the Broad River plant of the Broad River Power Co., at Columbia, S. C., has recently been ordered from the Westinghouse Co. The first unit of this plant was put in operation early in September. Details of the equipment and plant were published in the Sept. 22 issue of *Power*, page 468.

Colorado River Rights Being Considered by Arizona

Conferences between representatives of Arizona, California and Nevada are under way with a view to working out the terms of an agreement acceptable to these three states for the development of Colorado River power and the allocation of water. Some progress in this direction has been made and a proposal approved by California and Nevada delegates was taken under advisement by the Arizona committee with prospect for another joint meeting.

A résumé of the agreement as proposed by California and Nevada is:

1. All water contributed by Arizona rivers to be used solely by Arizona—approximately 1,000,000 acre-feet.

2. Water which is now being used by the states is definitely allocated to the present users. Rights to this water are not in any way affected by the present proposal.

3. One million, ninety-five thousand acre-ft. allocated to California. This is the equivalent of the 1,500 sec.-ft. which has been filed upon by California municipalities for domestic water.

4. Three hundred thousand acre-ft. allocated to Nevada in addition to the entire output of the Virgin River.

5. All remaining water to be divided equally between California and Arizona, with a provision that any of this water which is not in beneficial use by 1975 shall be available for definite allocation to either California or Arizona. This is to protect Arizona in case California should develop a "beneficial use" for the water more rapidly than Arizona.

6. Arizona and Nevada are to be paid one dollar per horsepower of electric energy developed at Boulder Canyon. It is estimated that this will amount to $1,000,000 per year.

The Federal Power Commission was directed under a joint resolution, adopted on Dec. 22 by the Senate, to suspend the granting of all power licenses on the Colorado River and its tributaries until Feb. 1, 1928. This action was considered necessary so that the consummation of a national policy for the co-ordinated development of the entire river for the highest use of its waters might be formulated.

Big Steam Plant Planned for Central Ontario

In a letter written to the mayor of Toronto recently, C. A. Magrath, the new head of the Ontario Hydro Electric Commission, stated that the Commission has not abandoned its plans for a big steam plant in Central Ontario, and has it under consideration. Mr. Magrath also stated that the generating capacities of the Commission will be fully used by the winter of 1926, necessitating additional generating capacity by the fall of 1927.

Horseshoe Lake Plant To Be Enlarged

A new 27,000-hp. generating unit, with the necessary condensing equipment and auxiliaries, will be installed at the Horseshoe Lake plant of the Oklahoma Gas & Electric Co., near Harrah, 23 miles east of Oklahoma City. This installation will cost approximately $1,250,000 and will increase the generating capacity of this plant to 47,000 hp. The plant was completed and put in service during 1924, with an initial installed capacity of 20,000 horsepower.

Muscle Shoals Resolution Scheduled for Jan. 5

Unexpected determination was shown by the Rules Committee of the House of Representatives last week in reaching an agreement upon certain phases of procedure in the Muscle Shoals matters. Representative Snell, of New York, the chairman of the committee, and Representative Garrett, of Tennessee, the ranking Democrat, were designated as a subcommittee to draft a resolution to be submitted to the full committee Jan. 4. If the committee can agree on a resolution at that session, it will be made the order of business in the House on Jan. 5.

The instructions to the subcommittee were that the resolution provide for a joint committee to be composed exclusively of members of the House and Senate and that the committee be clothed with authority to enter into negotiation for bids for a lease of the property for the manufacture of nitrates for fertilizer purposes in time of peace and for explosives in time of war.

The Joint Congressional Committee will be instructed to introduce a bill not later than April 1, providing for the acceptance of the offer it regards as the best. It is probable that the Joint Committee also will be instructed to report a plan for government operation in the event no satisfactory bid is received.

There is a desire on the part of some members to limit the committee further by requiring it to favor the offer that most nearly parallels the Ford offer.

Mr. Garrett, after the meeting of the Rules Committee, said: "In the President's annual message he unfortunately belittled the Muscle Shoals project, but his recommendation of a joint committee, the principle of which has been tentatively indorsed by the Rules Committee, seems to be the best avenue of approach to the subject under present conditions. I shall urge its creation, and from information I have I believe there is a chance of securing a satisfactory bid for private operation. If we do not get such bid, however, there is but one alternative and that is government operation. The importance of that great plant for the manufacture of nitrates for fertilizer in order that we may break the monopoly now held by Chilean nitrates over the farmers of America is too great to permit of its standing idle longer."

Appendix to Shoals Majority Report Ignores Power

An appendix to the majority report submitted by the President's Muscle Shoals Commission undertakes to prove that a large saving to the farmer could be brought about by the use of concentrated fertilizer manufactured at Muscle Shoals. A comparison is made between the average cost of mixed fertilizers and of concentrated mixed fertilizer such as would be produced at Muscle Shoals under this plan.

With the exception of a letter from Major Tyler, the district engineer at Florence, Ala., dealing with the cost of energy at Muscle Shoals, the appendix makes no reference to the power situation. The appendix, which is the work of W. G. Waldo, the Commission's technologist, originally contained a chapter dealing with the power situation, it is understood, but Commissioners McKenzie and Dial were unwilling to include it in the appendix.

The Waldo appendix when printed will cover some 65 pages. Part I is a historical outline of the Muscle Shoals project. Part II is devoted to descriptions of the nitrate plants and the dam. Parts III, IV and V, which constitute the bulk of the report, deal with estimates of fertilizer production costs at Muscle Shoals and the benefits to agriculture that would follow large-scale fertilizer manufacture there.

"Concentrated fertilizer materials," says the Waldo appendix, "produced under favorable circumstances such as exist at Muscle Shoals, with profits limited to 8 per cent on the annual cost of production and with direct cooperative distribution, can be expected reasonably to reduce the delivered cost of mixed fertilizers by about 43 per cent. Half-price fertilizers appear to be feasible under such a plan.

"From the reports of county agents the actual average cost per ton of the average mixed fertilizer used in each state was confusing. The average for all states was $36.77 per ton. This shows a saving of $16.03 per ton.

"The average for all states studied showed that the plant food in one ton of commercial ammonium phosphate, costing $70.23 f.o.b. Muscle Shoals, costs the farmer $146.87 when he buys his plant food in the form of factory-mixed fertilizers of the average grade.

"The study shows that the farmer can buy the average grade of mixed fertilizer at $36.78 per ton. He can buy the same amount of the same plant food in the form of unmixed ingredients for $25.82, while the estimated cost delivered of the same plant food in a concentrated mixture from Muscle Shoals would average $20.74."

Falls of Ohio River To Have Large Plant

Announcement has been made by the Byllesby Engineering & Management Corp., the operating firm for the Louisville Hydro-Electric Co., that an order for eight 13,500-hp. waterwheels has been placed with the Allis-Chalmers Manufacturing Co. This equipment is for the new Falls of the Ohio River station being built on the Ohio River at Louisville. It is claimed that this will be the seventh largest hydro-electric plant in the United States. It is expected that other equipment will be ordered shortly.

Fort Lauderdale, Fla., to Have New Steam Plant

Growing demand for electric power in Florida has caused the completion of negotiations by the Florida Power & Light Co. for the purchase of a large tract of land on the New River near Fort Lauderdale, on which work will be begun immediately for the construction of a new steam generating station to have an ultimate capacity of 100,000 kw. Orders have already been placed for two 25,000-kw. high-pressure steam turbines, boilers and auxiliary equipment for this station, and it is expected that the first unit of the plant will be installed and in operation by the end of 1926 or early in 1927. This station will be equipped to burn either coal or fuel oil or both, and rail and water transportation will be available for fuel deliveries.

W. W. Hatton Wins Prize for Power Show Slogan

In November the Midwestern Engineering Exposition, known also as the Chicago Power Show, offered a $100 prize for the best slogan accompanied by the best explanatory letter suitable for use in connection with the exposition which is to be held in Chicago, Jan. 26-30. Several hundred slogans were received coming from all parts of the country, some as far away as England and South America.

"Power Controls Man's Progress" was the winning slogan, and William W. Hatton of 120 Broadway, New York City, was the winner. Mr. Hatton's letter accompanying the slogan was as follows:

> Since man fashioned the first crude tools from trees and rocks, his progress has been ever cumulative. His use of tools, and their refinement, power, has marked the several steps of progress in civilization. His utilization of the water-driven wheel, the stored energy of combustion, the power of controlled steam and gas, all led to the innumerable uses of electricity when that marvel was brought within his ken.
>
> Today, vast as has been his accomplishment in the physical realm, let him in humility study the giant steps of his progress, and admit the possibility of even more amazing advance in applying the forces of Nature; let him use his accumulated knowledge for devising further aids to civilization, to the end that mankind, having lifted to some extent the curse of Adam, may have more leisure, acquire more culture and greater opportunities to develop the soul.

There were other slogans deserving of special merit, the authors of which will be properly recognized and suitable awards made during the week of the Chicago Power Show at the American Exposition Palace, January 26 to 30.

To Study Low-Temperature Carbonization of Utah Coals

An investigation to determine the distillation products of low-temperature carbonization of Utah coals at various temperatures and under different conditions will be undertaken by the Bureau of Mines at the Pittsburgh Experiment Station. The following conditions will be studied: Natural gas in atmosphere of superheated steam, in atmosphere of preheated natural gas, in atmosphere of products of combustion of natural gas and distillation by external heating retort.

Ozarks Company Gets Permit for Two Power Dams

The Arkansas Railroad Commission handed down a decision on Dec. 12 granting the application of the Ozarks Hydro-Electric Power Co. for a permit from the state to construct power dams in White River near Yellville, also on the Big North Fork and Buffalo Rivers.

The decision was reached after a hearing that lasted three days in which the North American Co. and J. B. Miller, president of the Dixie Power Co., opposed the application of the Ozarks company.

Western Electric Forms New Company for Supplies

Announcement that the electrical supply business of the Western Electric Co. had been segregated from the telephone manufacturing business and incorporated under the name Graybar Electric Co., was made on Dec. 22. The new company is capitalized at $15,000,000, all owned by the Western Electric Co., which operates fifty-five distributing houses and serves more than 35,000 customers. Physical separation of the supply and telephone businesses of the Western Electric Co. was carried out in 1923.

Charles G. DuBois, president of the Western Electric, is chairman of the board of the new company. Albert Lincoln Salt, who started as an office boy in the Western Electric Manufacturing Co. 44 years ago, is president.

Buffalo River Station To Add 60,000-Kw. Turbine

The rapidly increasing load supplied by the Niagara system and the necessity of maintaining a proper balance in the supply of steam and hydro-power have made it necessary to add a 60,000-kw. turbine to the equipment of the River Station of the Buffalo General Electric Co. The construction schedule calls for the new unit to be in operation early in the fall of 1926.

The new unit will be rated 60,000 kw., 66,667 kva., 90 per cent power factor, three-phase, 25 cycles, 12,000 volts, and will operate at a steam pressure of 250 lb. gage, a temperature of 250 deg. superheat, and one inch absolute back pressure.

The River Station at present includes three 20,000-kw. and one 35,000-kw. turbine generators. These, as well as the large unit now to be added, are of General Electric manufacture.

New York State Will Not Join the Tri-State Power Pact

New York State Used 7,524,241,845 Kw.-Hr. During 1924

THE COMMITTEE appointed by Governor Smith to confer with committees representing New Jersey and Pennsylvania, to consider forming compacts for interstate transmission of electric power, has disagreed with the two other committees which favored the idea, and has withdrawn from the conferences. This action took place at a meeting Dec. 22.

William A. Prendergast, chairman of the Public Service Commission, and the head of the committee of this state, gave out a memorandum on Dec. 23 calling attention to Section 30 of the Public Service law of Pennsylvania which gives the commission power to function under agreements or compacts with other states. Mr. Prendergast explained that such a provision gives Pennsylvania the privilege of co-operating with other states in emergencies, but does not bind that state to co-operate unless there is an emergency.

Mr. Prendergast said there need be no fear of the electric companies forcing overcharges on the consumers because the Public Service Commission has the power to fix rates, and that if the need arises Congress could be petitioned to fix rates in interstate transmission of power.

Chief Engineer Vanneman, of the Public Service Commission, and Commissioner Lunn were the other two representatives of this state beside Mr. Prendergast. They summarized their opposition to a compact by declaring that "a state compact provides a cumbersome and indirect method for correcting a minor deficiency in the present system of regulation; it is to be applied to conditions to be met in an unknown future; when these conditions are encountered, prompt relief is prevented by the compact, since amendment is as difficult as the adoption of the compact itself; it thus limits the freedom of future action, does not add to the regulatory powers of any of the states, is unnecessary, surrenders state sovereignty, and furnishes an entering wedge to complete Federal regulation of local problems."

While the New York representatives have opposed this tri-state power compact and have withdrawn from the conferences, Chairman Prendergast announced two alternatives. The first is that states which are sincerely desirous of co-operation enact a law similar to that prepared by the Public Service Commission of Pennsylvania and approved by the legislature of that state. This law permits joint investigations, joint hearings and the issuance of joint orders by more than one state or with the Federal government, but would not provide a permanent compact. The other suggestion was that the states ask Congress to empower the state public-service commissions to regulate interstate transmission of power. This method is declared by Mr. Prendergast simpler than a compact, as it requires but one legislative movement.

"We need only refer to the experience of the proposed Delaware River compact among New York, New Jersey and Pennsylvania to evidence the delays incident to compact procedure," Mr. Prendergast said. "A bill has been introduced in the present Congress prepared by the National Association of Railway and Utilities Commissioners which would grant to the state commissions power to regulate interstate motor bus traffic. There is no reason why the same action should not be taken in regard to interstate transmission of power."

Under present conditions, where no compact has been entered into by states, regulation is vested in the commission of the state where the distribution of the power takes place. Where a company generates and distributes its power without crossing a state boundary, the entire process is naturally under the control and supervision of the commission of that state. Any other procedure would be a surrender of state sovereignty, it is held.

The growth of large interconnections between power companies, forming the so-called superpower systems, has brought the question of the regulation of interstate transmission before the governmental bodies. Nevertheless, as pointed out by Mr. Prendergast, the exchange of power in the State of New York is relatively very small. In the year 1924 the total exports and imports represented 8.25 per cent of the total sales.

New York Electric Current, 1924

The memorandum contains this information concerning the business of manufacturing electric current:

"There were generated in the State of New York in 1924, 7,119,689,000 kw.-hr.; at the same time there were purchased 404,552,845 kw.-hr., making a total of 7,524,241,845. During the same year there were sold in the State of New York 5,933,000,000 kw.-hr. and there were exported from the state 86,459,504 kw.-hr., making a total of sales of 6,019,459,504. There were imported 411,489,705 kw.-hr.; the total of the exports and imports was 497,949,209 kw.-hr. To show the significance of this, the total exports and imports represent 8.25 per cent of the total sales; the total exports represent 1.45 per cent of the total sales; the total exports represent 1.21 per cent of the total kilowatt-hours generated."

The memorandum says that a consideration of the problem does not lead to the conclusion "that there will be in the future an enormous transfer of electricity from one state to another" and it says there should be an interchange of electricity between contiguous territories, "but this interchange will come about largely through temporary necessities. These demands will in the progress of industry be met by readjustments, so the situation thus created would be sooner or later entirely wiped out."

Island Falls Plant Started

The Abitibi Power & Paper Co. of Northern Ontario is now receiving power from its Island Falls plant, and steam is now being generated in electrical boilers, and is being distributed through the mill.

National Academy of Science Seeks Research Endowment

The National Academy of Sciences has asked the co-operation of a group of prominent men and leading American scientists in an effort to obtain larger resources for research in pure science.

The Academy hopes to obtain $2,000,000 annually with which to establish National Research professorships and to co-operate with universities and other institutions that are prepared to encourage fundamental research in the mathematical, physical and biological sciences.

The Academy has created a special board of prominent men to act as trustees for this endowment.

Personal Mention

John W. Armitage has accepted the position of chief engineer of the Hotel Chelsea, Atlantic City, N. J.

Richard W. Saunders has left Meriden, Conn., and is now Canadian manager of the C. J. Tagliabue Manufacturing Co., Toronto, Canada.

H. C. Bushnell, formerly designing engineer with the Pennsylvania Water & Power Co. at Baltimore, is now with E. L. Philips & Co., New York City.

W. A. Carter has been appointed technical engineer for the production department of the Detroit Edison Co., to replace C. H. Berry, who resigned to become associate editor of *Power*.

Carl Creutz, formerly with the Babcock & Wilcox Co., of Bayonne, N. J., has joined the engineering staff of the United States Aluminium Co. at Pittsburgh.

Elmer L. Liedel has been appointed boiler-room engineer of the Delray power plant of the Detroit Edison Co., replacing Julian Harvey, who has been assigned to the Connors Creek plant, of the company.

Manfred K. Toeppen has resigned from the position of chief engineer of the Michigan Public Utilities Commission and has opened offices in Detroit, where he will engage in consulting engineering.

Julian Harvey has been appointed technical engineer, Connors Creek power plant of the Detroit Edison Co., replacing H. E. Macomber, who has been assigned to Trenton Channel. Mr. Harvey was formerly boiler-room engineer of the Delray power plant.

C. J. Green, chief engineer of the Public Service Commission of Oregon, has been appointed assistant chief accountant-engineer of the Federal Power Commission, Washington, D. C. Mr. Green has been affiliated with the Oregon Public Service Commission since 1913, engaged in analyzing inventories and appraising hydro-electric properties.

J. S. Sutherland, formerly with the Ford Motor Co., has been appointed as district sales representative at Detroit for the Pittsburgh Valve, Foundry & Construction Co.

H. E. Macomber, who has been technical engineer at the Connors Creek plant of the Detroit Edison Co., has been appointed technical engineer at Trenton Channel, replacing A. K. Bak, who returned to Denmark recently.

Charles David Marx, professor emeritus of civil engineering in Leland Stanford, Jr., University, has been elected chairman of the Engineering Foundation Committee on the Arch Dam Investigation. He succeeds Prof. C. Darleth, Jr., of the University of California, who retires from the chairmanship on account of ill health, but who will continue as a member of the committee.

Society Affairs

The Metropolitan Section of the A.S.M.E. will hold a meeting on Jan. 14, at which "Welded Pressure Vessels" will be discussed.

The Washington, D. C., Section of the A.S.M.E. will hold a joint meeting with the A.I.E.E. at the Cosmos Club. "Superpower" will be the subject, which will be taken up by speakers of national importance on Jan. 12.

The Lehigh Valley Section of the A.I.E.E. will hold its Jan. 20th meeting at Easton. "Research of Today the Engineering of Tomorrow," by E. B. Craft of the Bell Telephone Laboratories, Inc., will be the attraction.

The Engineers' Society of Milwaukee recently elected officers for the following year as follows: Fred C. Trubshaw, president; Arthur C. Flory, vice-president; Robert Cramer, secretary; Walter R. Mueller, treasurer.

The Russian Association of Engineers, 136 Liberty St., New York City, will hold a meeting at the Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 29, at 8.15 p.m. Dr. Ernest Raymond Lilley, professor of geology at New York University, will speak on "Recent Technical Advances in Cracking and Refining and Their Effect Upon the Petroleum Oil Reserves."

A National Heating and Ventilating Exposition will be held in the new Madison Square Garden, New York City, March 17-23, according to an announcement recently made by the National Exposition Co., Hotel McAlpin, New York City. It is stated that plumbing, refrigerating and illuminating products will be displayed in this exposition, which is managed by E. P. Frenz.

The Pennsylvania State College Branch of the A.I.E.E. will hold a meeting on Jan. 13 devoted to Superpower. The papers will be given as follows: "Generation of Superpower," by D. E. Trucksess; "The Transmission of Superpower," by J. H. Garbrick; "The Utilization of Superpower," by M. S. Longenecker; "Criticism of Superpower," by A. P. Jackel; "Answers to Criticism," by H. M. Patrick.

Business Notes

The Bridgeport Brass Co., Bridgeport, Conn., announces that H. A. Watkins has recently been appointed Metropolitan sales representative with offices in the Pershing Square Bldg., New York City.

The Cokal Stoker Corp. has removed its offices to the Wrigley Bldg., Chicago, Ill. The CombustiKator Co., a subsidiary of the CoKal Corp., is handling all CombustiKator sales independent of the parent organization.

The Oxweld Acetylene Co., 30 East 42d St., New York City, announces the appointments of: J. N. Walker as general sales manager, L. D. Burnett as sales manager for Eastern department, Z. T. Davis, Jr., as assistant sales manager, Eastern department.

The Reading Iron Co., Reading, Pa., has acquired the services of Clyde L. Jones, formerly with the Interstate Pipe Co., to facilitate the service in the St. Louis territory. His headquarters will be 1819 Railway Exchange Bldg., St. Louis, Mo.

The Mount Morris Valve Corp., Mount Morris, N. Y., announces that it has recently purchased the patterns, the old "MH" trademark rights and good will of the McNab & Harlin Manufacturing Co., and will continue the manufacture of the principal standard brass valve lines.

The Chicago Pneumatic Tool Co., 6 East 44th St., New York City, has effected arrangements with the Motoren-Werke, Mannheim, Germany, whereby they have acquired the exclusive rights to manufacture and sell the Benz solid injection Diesel engine in the United States and Canada.

The Chicago Fuse Manufacturing Co., manufacturers of fuses, cutout bases, outlet boxes, switch boxes, etc., announced the appointment of Lowell C. Noyes as district sales manager in charge of the Chicago territory. He will have his office at the company's general offices and factory at 15th and Leflin Sts., Chicago.

Foote Bros. Gear & Machine Co., 215 N. Curtis St., Chicago, Ill., announces that George Roberts is its representative for Detroit and environs. His headquarters will be at 576 Montclair St., Detroit, Mich. The Power Equipment Co., 315 Third Ave., North Minneapolis, Minn., is representing the company in this district. M. A. Hughes, Railway Exchange Bldg., Seattle, Wash. is representative for Seattle.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has opened a new district office in Lima, Peru, which is in charge of W. G. Bolton. This office, as well as the one at Oruro, Bolivia, is a branch of the Santiago, Chile, Office, of which W. R. Judson is manager. The Oruro office is in charge of P. G. Gilliard, succeeding Erling Winsnes, who has returned to the United States. C. F. Phillips has been placed in charge of the Wilkes-Barre office.

Trade Catalogs

Unit Pulverizer—Grindle Fuel Equipment Co., Harvey, Ill. Bulletin No. 7 describes this multi-stage unit pulverizer for firing boilers, furnaces, ovens, etc.

Grates—Neemes Foundry, Inc., Troy, N. Y. Bulletin No. 103 covers the grates manufactured by this company adaptable for all types of furnaces. It is well illustrated and can be had upon application to the manufacturers.

Motors—The Linzee Electric Motor Co., Mansfield, Ohio. Bulletin No. 100 describes with pictures, squirrel-cage induction motors, three- and two-phase, ball and sleeve bearing, manufactured by the company. Tables of dimensions are included.

Conveyor—Stephens-Adamson Manufacturing Co., Aurora, Ill. The "Labor Saver" is the title of Bulletin No. 148, describing the types of conveyors manufactured by this company. The different types are shown in detail in photos.

Spray Cooling Nozzles — Schutte & Koerting Co., 1150 Thompson St., Philadelphia, Pa. Bulletin No. 5-N covering recooling spray-nozzle systems made by this company, replaces Catalog No. 2 on condensers and recooling systems. The new type of single-orifice flat-spray type of cooling nozzle is featured in this bulletin.

Water Softening—International Filter Co., 333 West 25th Place, Chicago, Ill. Bulletin H-63 covers the hot-flow softener and Bulletin 73 the Type "J" or cold-process water softener, manufactured by this company. The bulletins are profusely illustrated and contain full information in regard to the equipment.

Speed Reducers — DeLaval Steam Turbine Co., Trenton, N. J. Speed reducers for use with standard or high-speed motors includes worm reduction gears of horizontal and vertical shaft and double reduction types, also helical gears and double helical gears are described in a booklet recently published. Details of construction are shown by colored views.

Control Devices — General Electric Co., Schenectady, N. Y. "Industrial Control Catalog," 1925-26, is numbered Gea-257, and furnishes information on representative lines of industrial control manufactured by the company. It contains instructive matter on the care and operation of control devices, wiring diagrams of some standard controllers, push buttons, etc., reference tables and other useful information.

Boiler Water Conditioning — Hagen Corp., Pittsburgh, Pa. In an effort to find a satisfactory solution of boiler scale and corrosion, the Hagen Corp. in 1922 co-operating with the Bureau of Mines under the direction of Dr. R. E. Hall of the Bureau, instigated an investigation. The results of this research have been presented before various technical and scientific societies. The "Hall System" of boiler-water conditioning which is the outgrowth of this research, is described in a bulletin, "Water for Steam Generation," published by the Hagen Corp.

Steam Heat-and-Entropy Chart — DeLaval Steam Turbine Co., Trenton, N. J. This is the well-known Mollier diagram printed on a stiff sheet of Bristol board with a scale attached which can be broken off and used directly for measuring heat available, spouting velocity, pounds of steam per horsepower-hour and duty between given pressure limits on the entropy diagram; that is, the chart and scale give these quantities directly for a perfect heat motor. If the steam consumption of an actual engine or turbine is known, the efficiency ratio is found by a simple division. The quality of the steam at the end of a perfect expansion or at the end of actual expansion of known efficiency or steam consumption is also read off immediately from the chart. Copies will be sent upon request.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institute, Washington, D. C. Annual meeting at Kansas City, Dec. 28-Jan. 2.

American Boiler Manufacturers Association—Meeting at City Club, Cleveland, Ohio, Feb. 12.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12.

American Institute of Mining & Metallurgical Engineers. Dr. H. Foster Bain, 29 West 39th St., New York City. Annual meeting at Engineering Societies Bldg., New York City, Feb. 15-17.

American Oil Burners Association. Leod D. Becker, 350 Madison Ave., New York City. Annual convention and exposition at Book Cadillac Hotel, Detroit, Mich., April 6-8.

American Petroleum Institute—R. L. Welsh, 250 Park Ave., New York City. Annual meeting at Biltmore Hotel, Los Angeles, Calif., Jan. 19-21.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 20-22.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Annual meeting at Hotel Statler, Buffalo, N. Y., Jan. 27-29.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

Association of Municipal Electric Utilities. S. R. A. Clements, 190 University Ave., Toronto, Canada. Convention at Toronto, Ont., Jan. 27-28.

Engineering Institute of Canada. Richard John Durley, 176 Mansfield St., Montreal, Que. Annual meeting at Toronto, Ont., Jan. 27-29.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Iowa Engineering Society. J. S. Dodds, Box 202, Ames, Iowa. Convention at Mason City, Iowa, Jan. 27-29.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, American Exposition Palace, Jan. 26-30.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Society of Automotive Engineers. Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at the General Motors Bldg., Detroit, Mich., Jan. 26-29.

Western Association of Electrical Inspectors. W. S. Boyd, 175 West Jackson Blvd., Chicago, Ill. Meeting at Hotel Sherman, Chicago, Ill., Jan. 26-28.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Dec. 21 1925
Pool 1	New York	$2.75@$3.15
Smokeless	Boston	2.24
Clearfield	Boston	1.75@ 2.25
Somerset	Boston	1.85@ 2.40
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.75@ 2.00
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.35@ 2.65
Central, Ill.	Chicago	2.25@ 2.35
Ind. 4th Vein	Chicago	2.25@ 2.35
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	2.00@ 2.25
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.75
Buckwheat No. 1.	Philadelphia	2.50@ 3.00
Birdseye	New York	

FUEL OIL

New York—Dec. 23, light oil, tank-car lots; 28@34 deg. Baumé, 5@5¼c. per gal.; 36@40 deg., 5¼@5½c. per gal., f.o.b., Bayonne, N. J.

St. Louis—Dec. 15, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.4c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Dec. 15, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Dec. 12, f.o.b. local refinery; 26@30 deg., $1.55 per bbl.

Philadelphia—Dec. 17, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.65@ $1.71 per bbl.

Boston—Dec. 21, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.55c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Dec. 14, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6½c. per gal.; 26@30 deg., 7c. per gal.; 30@32 deg., 7¼c. per gal.

Chicago—Dec. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl.; 26@30 deg., $1.35; 30@32 deg., $1.40.

New Plant Construction

Ala., Fairfield—Tennessee Coal Iron & Railway Co., Brown-Marx Bldg., Birmingham, plans the construction of an electric power station to utilize gas of new blast furnaces also install two 25,000 kw. turbo generators here.

Ala., Gantt — Norse Shoe Lumber Co., plans the construction of a hydro-electric plant, 3 units 2,000 kw. each on Pattsaliga Creek near here. Southern Engineering Corp., Albany, Ga., is engineer.

Calif., Bakersfield—San Joaquin Light & Power Co., Bower Bldg., Fresno, appropriated funds for the construction of substations and power lines in Kern county district here. Estimated cost $1,000,000.

Calif., Fresno—Forkner Properties Co., Inc., Fig Gardens, plans the construction of a pre-cooling and packing plant. Estimated cost $100,000.

Calif., Fresno — Pacific Fruit Express Co., 65 Market St., San Francisco, plans the construction of an ice manufacturing and storage plant 70,000 tons storage capacity here. Estimated cost $500,000.

Calif., Fullerton—City had plans prepared for the construction of La Habra sewage system including pumping station, pumps, etc. W. C. Record, is city engineer.

Calif., Ramona—Ramona Irrigation District, plans an election soon to vote $80,000 to $90,000 bonds to finance the installation of pumping plants. T. King, Fletcher Bldg., San Diego, is engineer.

Calif., San Francisco—A. Penziner, 750 Taylor St., had plans prepared for the construction of a 16 story hotel. Estimated cost $1,500,000.

Calif., San Francisco — E. Tropp, 129 Sutter St., is having preliminary plans prepared for the construction of a 14 story apartment on Pacific Ave. Estimated cost $750,000. Hyman & Appleton, 68 Post St., are architects.

Calif., Santa Maria—Midland Counties Public Service Corp., 206 West Main St., plans the construction of sub-stations, distribution lines, etc. Estimated cost $215,000.

Calif., Venice—J. M. Noell, 940 Venitian Ave., plans the construction of an ice manufacturing and cold storage plant. Estimated cost $125,000.

Colo., Denver—Minnequa Steel Works, E. H. Weitzel, V. Pres., subsidiary of the Colorado Fuel & Iron Co., Boston Bldg., plans the construction of a new steel plant, electrically operated. Estimated cost $1,500,000.

Fla., Miami—Riverside Ice & Cold Storage Co., 438 South West 17th St., awarded contract for the construction of an ice plant to G. H. Simmonite, 719 North West 13th Ave. $40,000.

Ill., Chicago—Frank Chase, Inc., 720 North Michigan Ave., Archt., is receiving bids for the construction of a 6 story hospital at Groveland Park and 33rd St. for Chicago Memorial Hospital, J. E. Wilder, Pres. Estimated cost $650,000.

Ill., Chicago—J. Glasser, 4645 Sheridan Road, awarded contract for the construction of a 6 story hotel at 4826 Sheridan Road, to Fitzgerald Construction Co., 500 North Dearborn St. Estimated cost $750,000.

Ill., Chicago—C. F. Henry, 7455 Greenview Ave., awarded contract for masonry, etc., for a 16 story apartment at Delaware Place and Seneca St., to McLennan Construction Co., 307 North Michigan Ave. Estimated cost $2,000,000. Thielbar & Fugard, 219 East Superior St., Archts., will receive bids on the balance of the contracts.

Ill., Chicago—D. A. Matteson, 77 West Washington St., plans the construction of a 16 story apartment at 1420 Lake Shore Drive. Estimated cost $2,250,000. Architect not selected.

Ill., Chicago—M. S. Plotke, 111 West Washington St., is having plans prepared for the construction of a 16 story hotel, stores and office building at Cass and Ontario Sts. Estimated cost $1,500,000. Huszagh & Hill, 6 North Michigan Ave., are architects.

La., Lake Charles—Louisiana Electric Co., plans the construction of a water purification plant including pumps, filter equipment, etc. Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, Mo., is engineer.

Md., Baltimore—Bd. of Awards, C. H. Osborne, Chief of Bureau of Buildings, City Hall, will receive bids until Dec. 30 for refrigerating machinery at Richmond Market, Howard St. and Armory Place.

Mass., Boston—Mark Temple Realty Co., c/o Crane & Frenzheim, 345 Madison Ave., New York, N. Y., Archts., is having preliminary plans prepared for the construction of a 12 story hotel on Commonwealth Ave., here. Estimated cost $6,000,000.

Minn., East Grand Forks—Ottertail Power Co., C. S. Kennedy, Gen. Mgr., Fergus Falls, plans the installation of power plant, 2 units, 2,000 hp. capacity each here. Estimated cost $400,000.

Mo., Mexico—Missouri Power & Light Co., 119 West Promenade St., plans improvements to ice plant. Estimated cost $75,000.

Mo., St. Louis—A. M. Frumberg, et al, Bank of Commerce Bldg., Broadway and Olive Sts., is having preliminary plans prepared for the construction of a 22 story hotel at 12th and Pine Sts. Estimated cost $850,000. Private plans.

Neb., Omaha—Peoples Ice & Cold Storage Co., 1224 Chicago St., awarded contract for remodeling of ice plant to Parson Construction Co., 404 Arthur Bldg. Estimated cost $100,000.

N. J., Newark—N. T. Hall, et al, c/o F. Grad, 1023 Broad St., Archt., is having plans prepared for the construction of an 18 story office building at Broad and West Kinney Sts. Estimated cost $1,750,000.

N. J., Spring Lake—City will readvertise for bids for a cross compound steam, two stage, air compressor, artesian wells, etc. J. L. Sweigard, 1120 Lincoln Bldg., Philadelphia, Pa., is engineer. Former bids rejected.

N. Y., Brooklyn—Realty Associates, S. Gumpertz, Pres., 162 Remsen St., is having plans prepared for the construction of an apartment at Boardwalk and East 4th St., Brighton Beach. Estimated cost $2,000,000. L. A. Goldstone, 512 5th Ave., New York, is architect and engineer.

N. Y., New York—Elizabeth Hospital, 415 West 51st St., is having plans prepared for the construction of a 6 story hospital at 190th St. and Fort Washington Ave. Estimated cost $800,000. O'Connor, Delany & Schultz, 162 East 37th St., are architects and engineers.

N. Y., New York—Fifty Seventh St. and Fifth Avenue Corp., G. M. Heckscher, Pres., 730 5th Ave., is having plans prepared for the construction of a 42 story hotel. Estimated cost $7,500,000. Allen & DeYoung, Inc., 277 Park Ave., are architects.

N. Y., New York—Forty Seven West Ninety Six Street Corporation, c/o E. Roth, 119 West 40th St., Archt., plans the construction of a 15 story apartment at 41 West 96th St. Estimated cost $500,000. Owner will build by separate contracts.

N. Y., New York—F. F. French Co., 350 Madison Ave., has purchased 50 acres of land and plans the construction of apartments on 1st and 2nd Aves. from 41st to 44th Sts. Estimated cost $25,000,000. Owner is general contractor and will award separate contracts.

N. Y., New York—Willets Construction Co., c/o Sloan & Robertson, 441 Lexington Ave., Archts., is having plans prepared for the construction of a 16 story office building at 112 East 32nd St. Estimated cost $600,000.

N. C. Kinston—W. A. Mitchell, Mayor will receive bids until Jan. 15 for sinking of one or two wells with vertical pump and motor to produce 500 gal. water per minute.

N. C., Stem—Stem Ginning Co., W. L. Pearce, Mgr., Oxford, is in the market for 60 hp. steam and oil engines.

O., Columbus—Buckeye State Building & Loan Co., 22 West Gay St., plans the construction of an 8 story bank and office building on East Gay St. Estimated cost $800,000. Hopkins & Dentz, 415 Lexington Ave., New York, N. Y., are architects.

O., Youngstown—G. L. Oles, plans the construction of a 7 story apartment at Boardman and Phelps Sts. Estimated cost $750,000.

Okla., Medford—United Power Co., R. H. Jarvis, Mgr., wants prices and data on two 260 hp. oil engines.

Okla., Miami—City, G. C. Brown, Clk., will soon receive bids for a 750 hp. Diesel engine unit.

Pa., Oaks—Philadelphia Rubber Works Co., Land Title Bldg., Philadelphia, will soon award contract for the construction of a plant including boiler house, here. Estimated cost $400,000. Osborn Engineering Co., Euclid Bldg., Cleveland, O., is engineer.

Pa., Philadelphia—Edelstein & Bernstein, 215 South 15th St., plans the construction of a 15 story office building at Fifteenth and Chanceller Sts. Estimated cost $400,000. Architect not selected.

Pa., Philadelphia—Zantzinger, Borie & Medary, Otis Bldg., Archts., will receive bids until Jan. 4 for the construction of an office and loft building at Parkway and Fairmount Ave. for Fidelity Mutual Life Insurance Co., 112 North Broad St. Estimated cost $1,500,000.

Pa., Pittsburgh—Fifth Avenue Apartment Corp., c/o P. Jullian, 823 15th St. N. W., Washington, D. C., Archt., is having plans prepared for the construction of a 9 story hotel. Estimated cost $2,000,000.

Pa., Pittsburgh—General Forbes Hotel Corp., Sixth St. and Penn. Ave., is having plans prepared for the construction of addition to hotel. Estimated cost $2,000,000. Weber & Wurster, 403 Morris Bldg., Philadelphia, are architects.

Pa., Pittsburgh—Rowland & Clark Theatre Corp., 893 State Theatre Bldg., is having plans prepared for the construction of a 20 story theatre and office building at Pennsylvania Ave., Seventh St. and Liberty Ave. Estimated cost $7,000,000. V. A. Rigamont, State Theatre Bldg., is architect.

Tenn., Nashville—Bd. of Public Works, S. H. McKay, Clk., will receive bids until Jan. 6 for the construction of a reservoir 2,000,000 gal. motor driven centrifugal pumps, three 500 hp. water tube boilers, underfeed stokers, coal and ash handling equipment, etc. The J. N. Chester, Engrs., 1111 Union Bank Bldg., Pittsburgh, Pa., are engineers.

Tenn., Nashville — City voted $100,000 bonds for the reconditioning of power plant and boiler equipment for city hospital. H. E. Howse, is mayor.

Tex., Dallas—J. N. McCammon, Inc., 604 Southland Life Bldg., is having plans prepared for the construction of a 24 story office building at Main and Akard Sts. Estimated cost $1,750,000.

Tex., Donna—Donna Irrigation District, Hidalgo County No. 1, plans to expend $175,000 for drainage facilities. Will purchase new pumps, etc. Total estimated cost $580,000.

Tex., Houston—J. Finger, 711 Keystone Bldg., Archt., will soon receive bids for the construction of a 16 story hotel at Rusk Ave. and Fanning St. for San Jacinto Hotel Co., c/o N. D. Naman, Second National Bank Bldg. Estimated cost $1,500,000.

Tex., Palestine—Palestine Ice Co., c/o W. B. McNaughton, plans the construction of an ice plant to replace fire loss. Estimated cost $70,000. Architect not selected.

Tex., Pharr—D. McLenton & M. H. Lowrie, et al, plans the construction of a cold storage plant. Estimated cost $28,000. Private plans. Machinery will be purchased.

Tex., Texarkana—Texarkana Ice Co., c/o J. N. Myers, will build a 25 ton ice plant at Twelfth and Walnut Sts., by day labor. Estimated cost $45,000. Private plans.

Wis., Cassville—Village, A. Finney, Clk., plans rebuilding electric light and power plant including new machinery, switchboard, etc. Estimated cost $25,000. Engineer not selected.

Wis., Madison—University of Wisconsin, J. O. Philips, Bus. Mgr., appropriated $49,000 for a new boiler, piping, etc., for heating plant. A. Peabody, State Capitol, is engineer.

Wis., Milwaukee — Metropolitan Sewage Commission, J. H. Fowles, Secy., 508 Market St., will receive bids until Dec. 30 for two 5,000 g.p.m. motor operated, float controlled centrifugal pumps, etc., for Mud Creek low level sewage booster station.

Wis., Trego—Wisconsin Hydro-Electric Co., E. J. Schneider, Pres., Amery, has been granted a permit by the State Commission to construct a hydro-electric power plant and a 560 ft., 28 ft. head dam on the Namakagon River near here. R. D. Thomas, 1200 2nd Ave. S., Minneapolis, is engineer.

Volume 62 December 29, 1925 Number 26

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Publishers of

Engineering News-Record — American Machinist
Power — Chemical and Metallurgical Engineering
Coal Age — Engineering and Mining Journal-Press
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Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place.

Published Weekly. Entered as Second-Class Matter, Dec. 20, 1910, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

Printed in U. S. A. Established 1880.

Member Audit Bureau of Circulation. Member Associated Business Papers, Inc.

NUMBER OF COPIES PRINTED THIS ISSUE, 28,515

Moments with the Ad Editor

Isn't this the time to take stock of oneself?

The end of the year in many a manufacturing plant is stock taking time—stock taking being necessary to make sure that the new year will be started with a definite knowledge of the condition of the business—with a definite knowledge of the exact point from which the new start will have to be made.

Stock taking is necessary as well, to determine the condition of the equipment and the organization at the command of the business—the available tools with which new progress marks are to be made.

Isn't this an equally good time in which to take stock of oneself?

To ask oneself just how our own equipment measures up to the task we are setting for our next year's efforts.

Are we as fully informed on this subject and that as we should be—and are we planning to improve our equipment as the weeks go on—to enable us to cope with increasing ability with the problems which are continually confronting us in our day's work?

Our various conclusions regarding our fitness, when stock taking has been finished, may differ—but on the question of improving our knowledge of methods to employ to secure improved results in our plants, "weekly reading of the ad-pages," is the answer we all agree on.

Let's make sure then, in jotting down the results of our taking stock that we all conclude with the resolution—for 1926—that weekly study of POWER'S ad pages will be the method we'll employ to keep up to the mark on modern ways of doing things.

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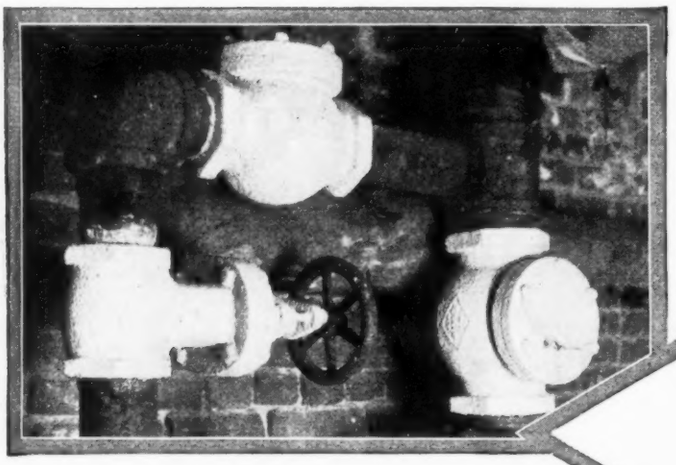
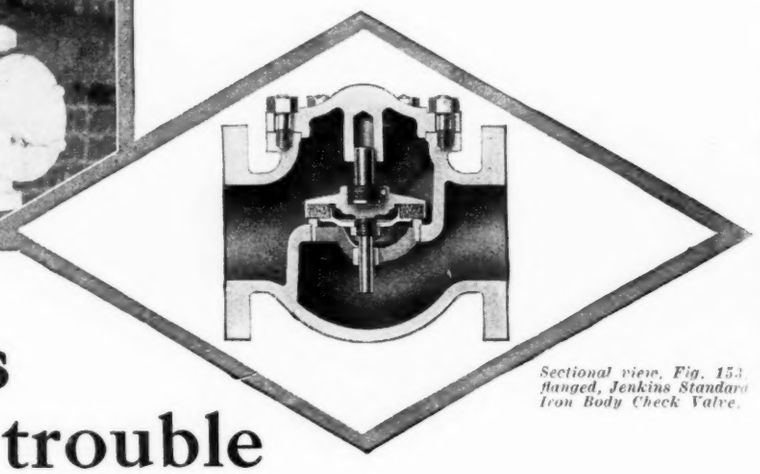


20 year old Jenkins Check Valves still serving on water line near meter. Old N. Y. Tribune Bldg., New York City.



Sectional view, Fig. 153 flanged, Jenkins Standard Iron Body Check Valve.

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The action of Jenkins Check Valves is prompt and reliable. Power plant engineers can depend on them for the many important jobs for which check valves are used.

The contact at the seat is leak-proof, each Jenkins Check Valve being fitted with a Jenkins Renewable Disc. In addition to insuring perfect contact, a Jenkins Disc takes up the wear of frequent opening and closing.

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Fig. 352
Screwed, Jenkins Standard Bronze Swing Check Valve

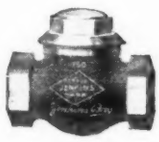
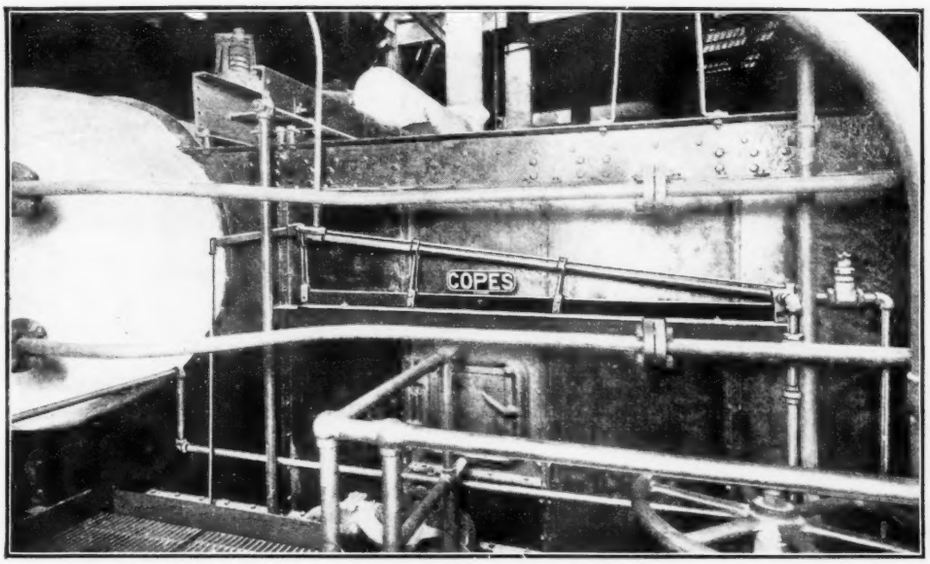


Fig. 117
Screwed, Jenkins Standard Bronze Horizontal Check Valve.

Fig. 118
Screwed, Jenkins Standard Bronze Angle Check Valve.

Fig. 151
Screwed, Jenkins Standard Iron Body Horizontal Check Valve.



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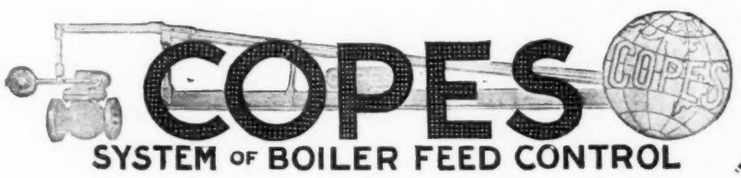

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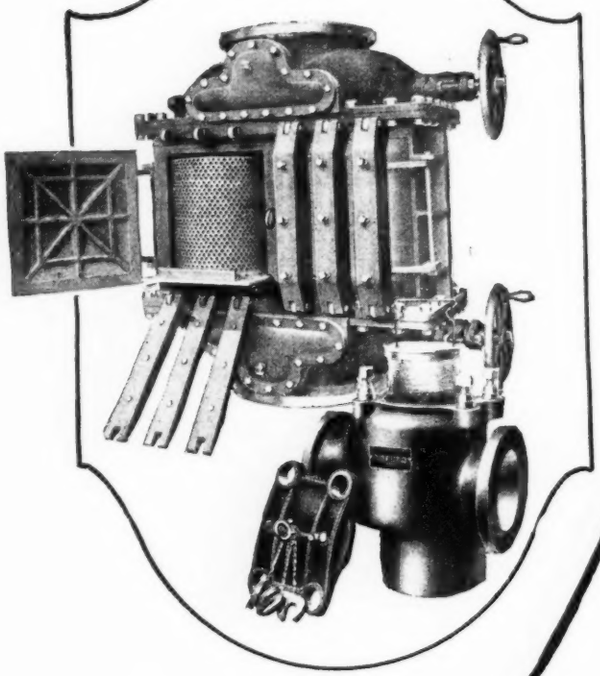

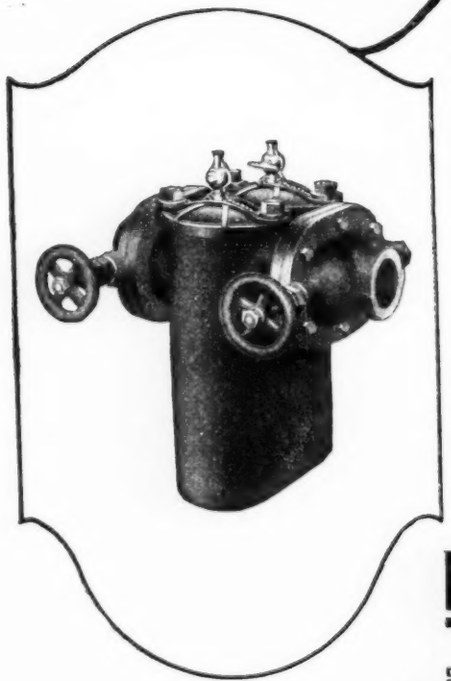

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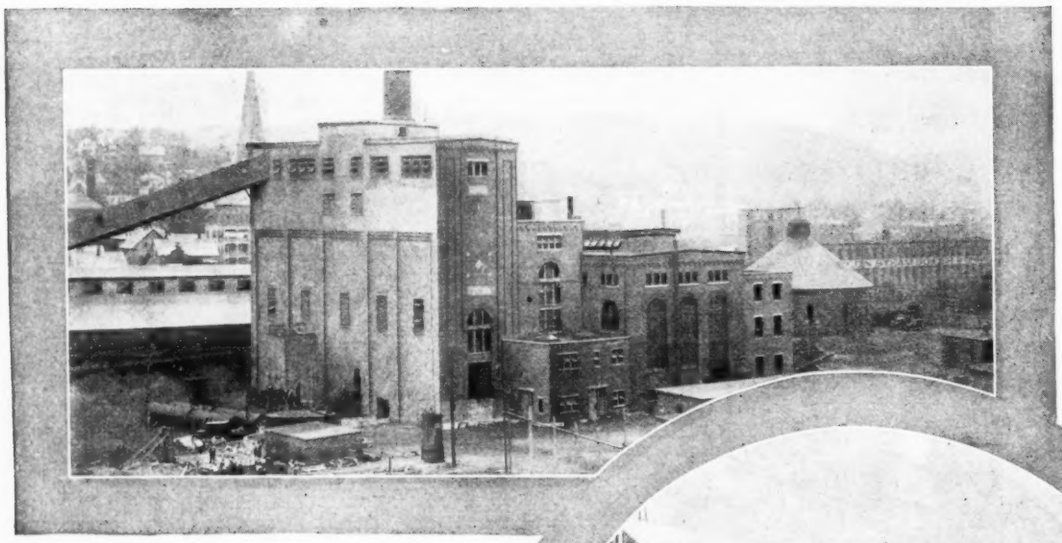

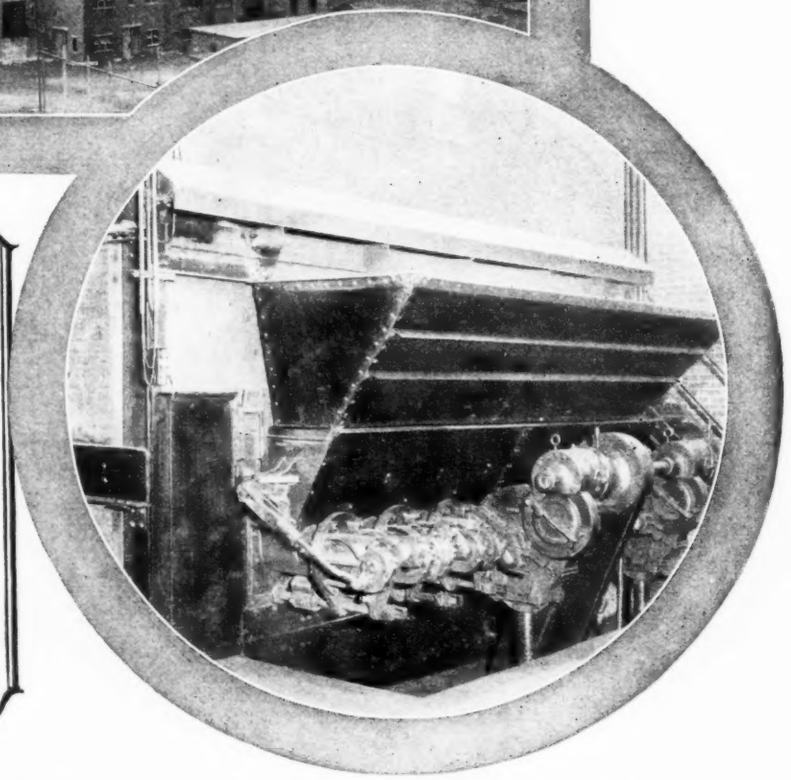

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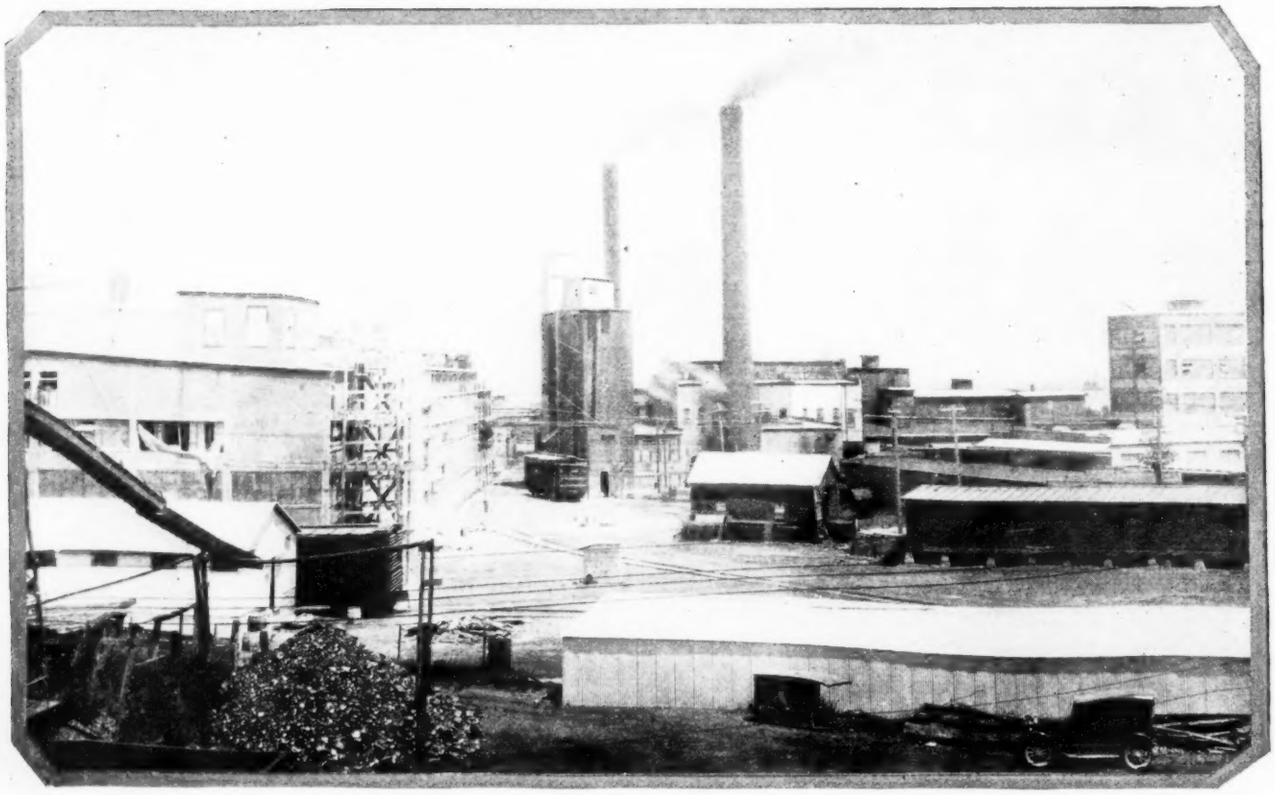
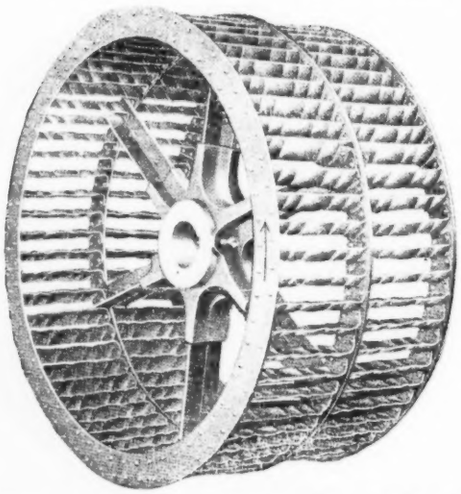


More and more does modern industry utilize Sturtevant Mechanical Draft Equipment



The use of a Sturtevant Multivane Fan by the Huron Milling Co., Harbor Beach, Mich., for furnishing induced draft to the boilers is an index of the way modern industry is continuing to use Sturtevant Mechanical Draft Equipment.

These Sturtevant Fans are giving uniformly dependable service at minimum maintenance and operating cost. The successful performance of these Fans under every operating condition is the result of years of experience, sound engineering principles of design, and superior manufacturing methods of construction.

Our Engineering Dept. is at your service to co-operate with you in the selection of the most suitable and economical mechanical draft equipment.

Sturtevant Products for Power Plants

FUEL ECONOMIZERS
Cast Iron
Steel Tube
Air Preheaters
Forced and Induced Draft Fans
Condensane Fans
Underfeed Stokers
Steam Turbines
Reduction Gear
Transmissions
Electric Motors
GENERATING SETS
Engine
Motor
Turbine
Feeder Blowers
Dryer Fans
Turbo Undergrate Blowers
Dust Blowers
Vacuum Cleaners
Air Washers
Transformer Fans

B. F. STURTEVANT COMPANY

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Sturtevant
PUTS AIR TO WORK

Tracyfiers Are Standard Equipment In This Central Station

Tampa Electric Company has standardized on Tracyfiers for all their boilers because, even with bad water conditions, the Tracyfiers assure them clean, dry steam and freedom from slugs of water.

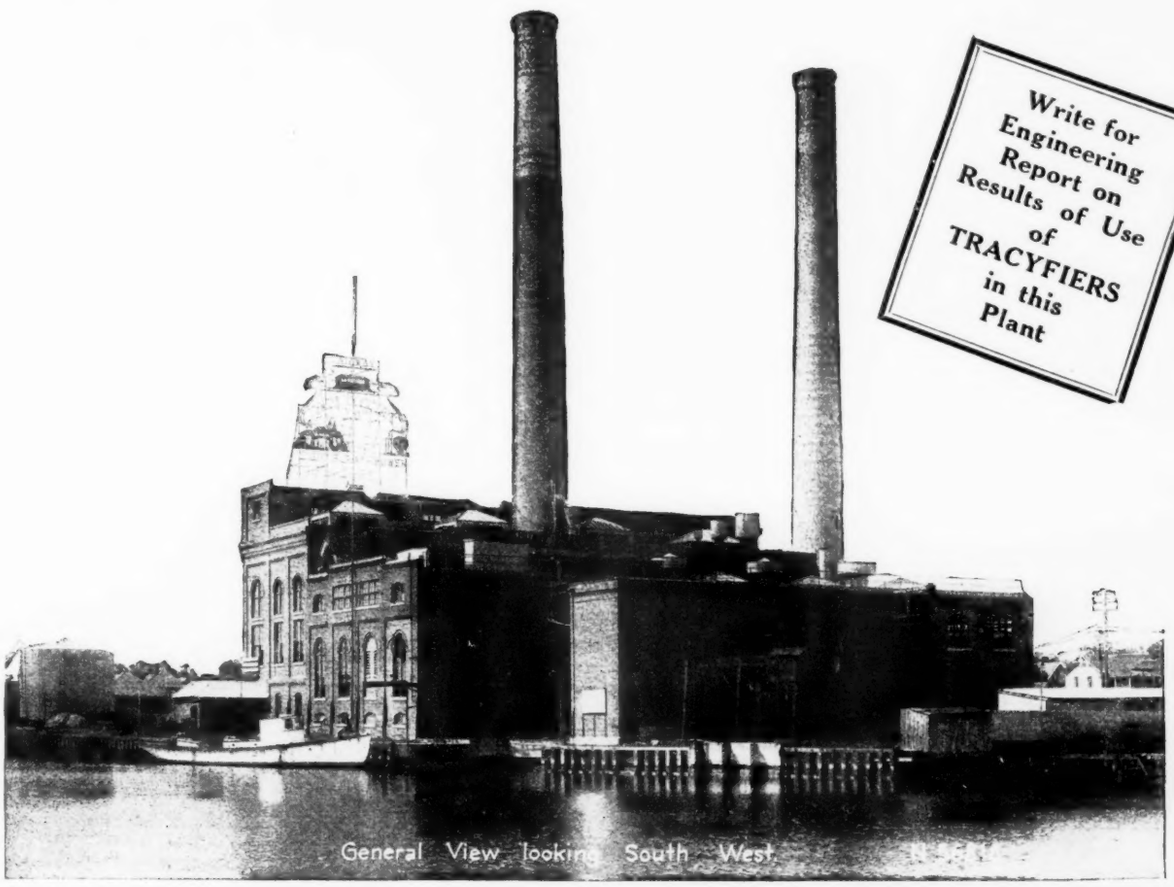
They have eliminated turbine blade erosion and necessity for frequent cleaning. They have increased their turbine efficiency by a considerable extent.

If your steam contains even as much as $\frac{3}{4}$ of 1% of moisture, you are, almost certainly, carrying MORE impurities over with your steam that you are eliminating through your blowdown.

Every trace of boiler water, either as delicate mist, fog, bubbles, or slugs is eliminated by Tracyfiers, allowing only dry and clean steam to leave the boiler drum.

Ask for report on Tampa Electric Company's Tracyfier Installation.

ANDREWS-BRADSHAW COMPANY
530 Fourth Avenue, PITTSBURGH, PA.



TRACYFIER

Harwood Station
Pennsylvania Light & Power Co.

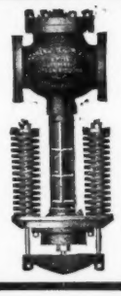
THIS plant is built over its own fuel supply; it uses coal as it comes from the mine.

BOWSER ESTABLISHED 1885

A great station, this at Harwood—and, like many other great stations today, depends on a complete Bowser continuous by-pass batch system to keep lubricating oil in good condition at all times, for the great turbines.

S.F. BOWSER & COMPANY, Inc.
LUBRICATION ENGINEERS AND MANUFACTURERS
FORT WAYNE, INDIANA, U.S.A.

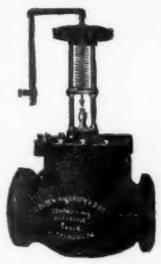
LUBRICATORS–OIL FILTERS–OILING SYSTEMS–ACCESSORIES
OIL STORAGE AND DISTRIBUTION SYSTEMS



GOLDEN-ANDERSON

Pat. Automatic Cushioned Steam Pressure Reducing Valves

1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout—practically indestructible.



GOLDEN-ANDERSON

Pat. Cushioned Automatic Controlling Altitude Valves

1. Automatically maintain uniform water levels in tanks, standpipes, reservoirs, etc.
2. For high or low pressure. Always dependable.
3. No floats or fixtures used.
4. No water hammer or shocks.
5. Sizes up to 30 in.

Double extra heavy semi-steel or cast steel bodies for highest pressures and superheat. Perfectly cushioned.

Double Extra Heavy Valves

A safe boiler room pays big dividends

Continuity of steam production with full protection of life and equipment make it a paying investment.

Your boiler room will be safe if you install

Golden-Anderson

Patent Automatic Double Cushioned Triple Acting and Non-Return Valves

Automatically cut out a damaged boiler.

Automatically shut off steam flow from every boiler when steam pipe bursts.

Automatically cut in fresh boilers.

Prevent back flow of steam into a cold boiler.

Fitted with double Corliss dash-pot.

Can be connected for closure by electricity or hand valves from distant points.

The only valves that can be tested in service from the boiler room floor.

"4500" Golden-Anderson Valves are protecting America's steel plants.

"Life and Property Insurance Valves"

"No Shut-down when a Boiler Tube Bursts"

"No Explosion when a Steam Pipe Breaks"

"Every valve with an absolute guarantee"

"Heaviest valves made"

GOLDEN-ANDERSON

Pat. Automatic Cushioned Controlling Float Valve

1. Automatically maintain uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle or Globe patterns to 30 in.

GOLDEN-ANDERSON

Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required —No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

GOLDEN-ANDERSON

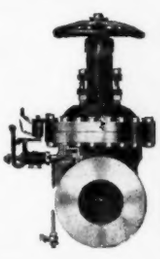
Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipes, etc.
2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—Most satisfactory float valves known.
4. No metal-to-metal seats — No water hammer or shock.
5. Cushioned by water and air.

GOLDEN-ANDERSON

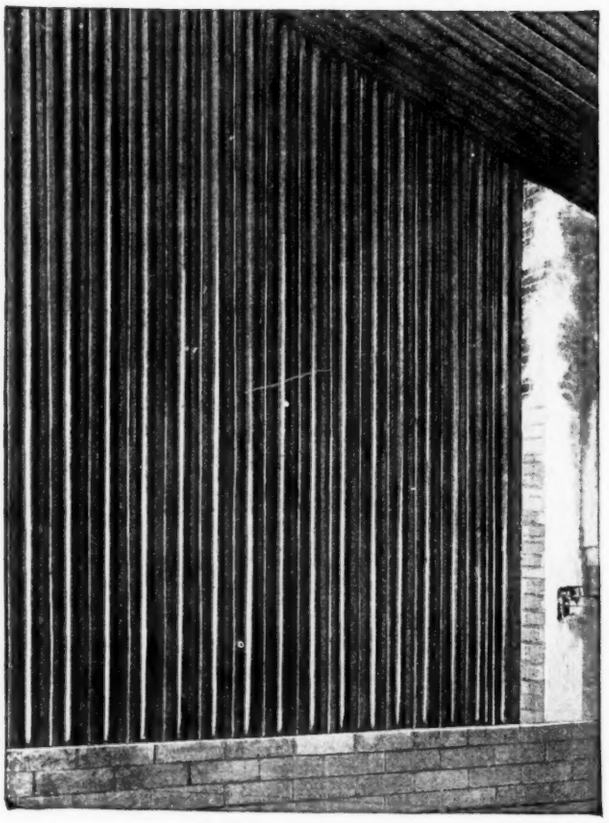
Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

1. Operate 3 ways: Automatically, by hand, or by electric switch.
2. Prevent fly-wheel explosions.
3. "Double Corliss" cushioned—No pounding or sticking.
4. Contains no tight fitting parts.
5. Furnished in angle and globe patterns for high or low pressures.
6. "Always ready for service."



Golden-Anderson Valve Specialty Co., 1217 Fulton Bldg., Pittsburgh, Pa.

Added Capacity From



C-E Fin Furnace Walls replace refractory walls

INTERNATIONAL - COMBUSTION

Combustion Corpor

43 Broad St., New York

Present Boiler Settings

C-E Fin Furnace Walls replace refractory walls with 100% boiler heating surface. Heat absorption and evaporation from Fin Furnace Walls are the same as in the first two rows of tubes in the boiler.

High CO_2 and high ratings are maintained without damage.

Capacities never before approachable become everyday performance.

Capital expenditures are lowered —space limitations are overcome —more steam at less cost per pound is the result.

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

- Lopulco Pulverized Fuel System
- Frederick Multiple Retort Stoker
- Self-contained Stoker
- Coxe Stoker
- Type E Stoker
- Type D Stoker
- Type K Stoker
- Type H Stoker
- Green Natural Draft Stoker
- Green Forced Draft Stoker
- C-E Fin Furnaces
- C-E Air Heaters
- C-E Unit System (Pulverized Fuel)
- Grieve Grates
- Combusco Ash Conveyors
- Quinn Oil Burning Equipment

ENGINEERING CORPORATION

Engineering

ration *Offices throughout the World*

Selling a boiler and selling absolutely dry steam are two different things —

Erie City Iron Works

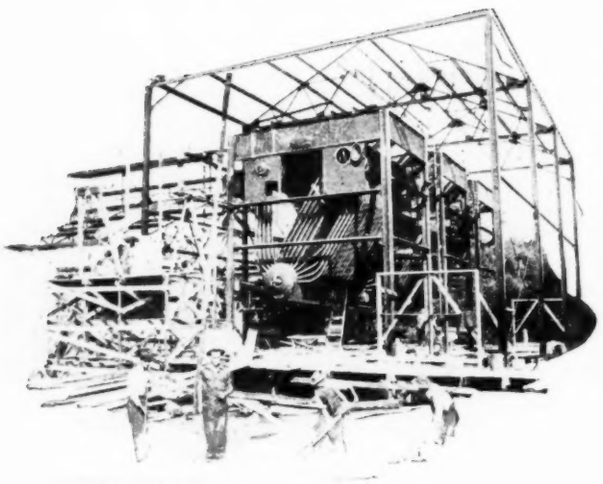
ERIE CITY IRON WORKS has long since passed the stage of merely selling *equipment.*

Modern power plant practice demands *more* than the ability of a manufacturer to "talk" boilers, engines, apparatus for burning powdered fuels, etc. Because such equipment, in the final analysis, is only a means to an end.

You buy the *result* of what the equipment *does.* Dry steam, higher economy, increased capacity—if it is a boiler. Power and economy—if it is an engine. Combustion efficiency, maximum economy and safety—if it is a pulverized coal equipment.

It is on this basis of producing the results you really buy with the proper methods of securing them that Erie City Iron Works can best serve you.

Erie City is a *service organization.* Its products, developed as the result of demands for greater efficiency and economies *from within the power plant field itself,* are an expression of its unusual ability to confront your problems on a true service basis.



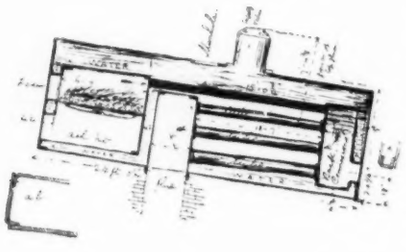
FOR SALE

Absolutely dry steam

secured by the Erie City Three-Drum Inclined Water-Tube Boiler. For sale also—freedom from priming, greater flexibility, greater efficiency, greater accessibility, high rating and wide and rapid fluctuating load.

THUS, as we said in the beginning, selling a boiler and selling absolutely dry steam are two different things. Erie City success, and its reputation for service to power users, is based on first determining the results to be achieved and then specifying the necessary equipment to make these results possible.

In 1880

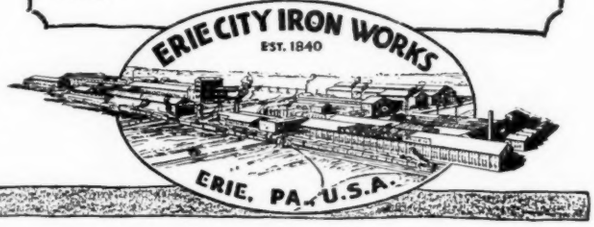


This Sketch Was Made and Sent to Erie City Iron Works,

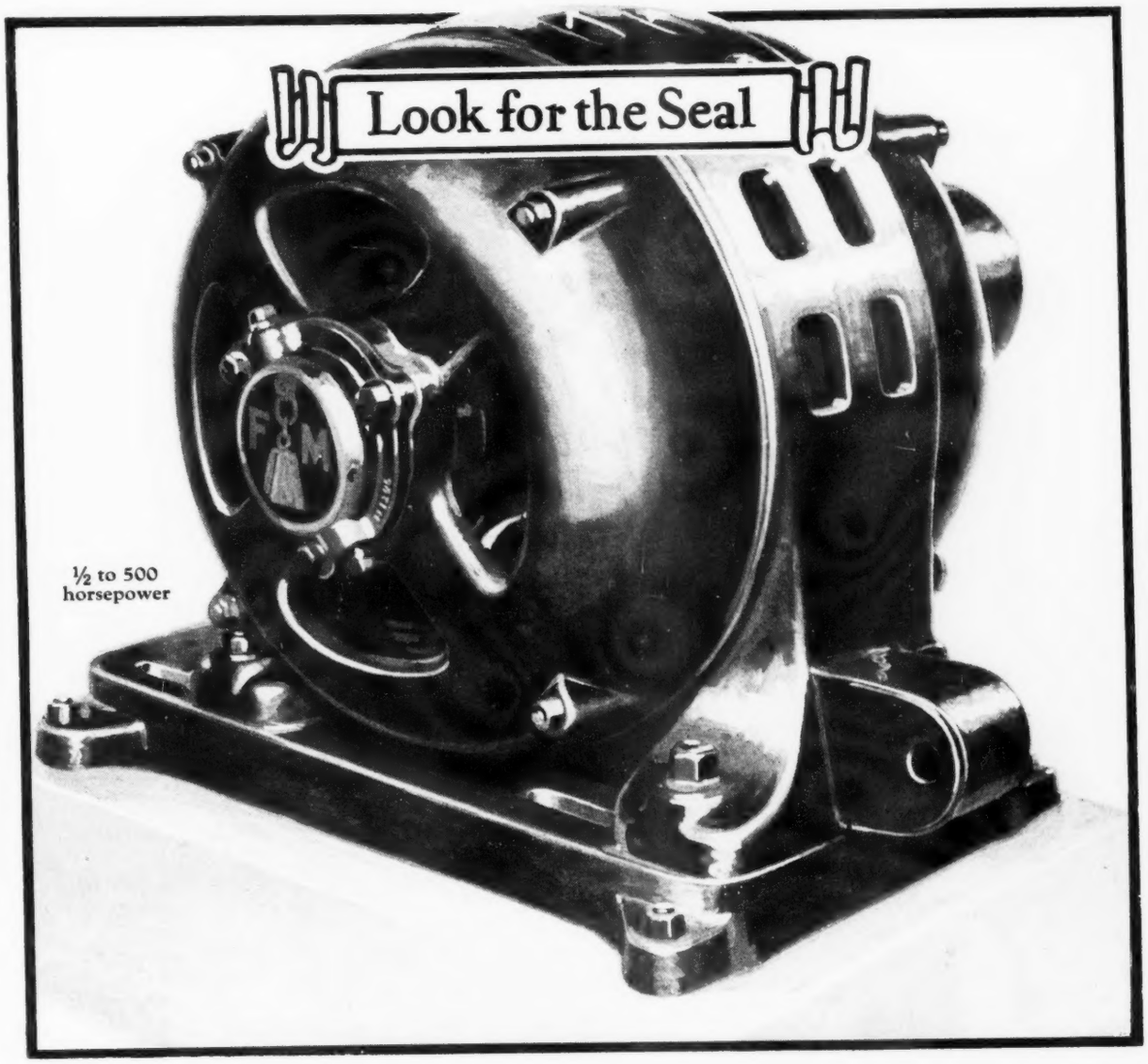
as a basis upon which to figure an installation. Designs and requirements of power users have changed, but Erie City Iron Work's serve today backed by a rich experience that dates down through the years to 1840. Progress in engineering and research development has kept pace with and many times pointed the way in power plant practice down through the years to the present date.

MODERN STEAM POWER PLANTS

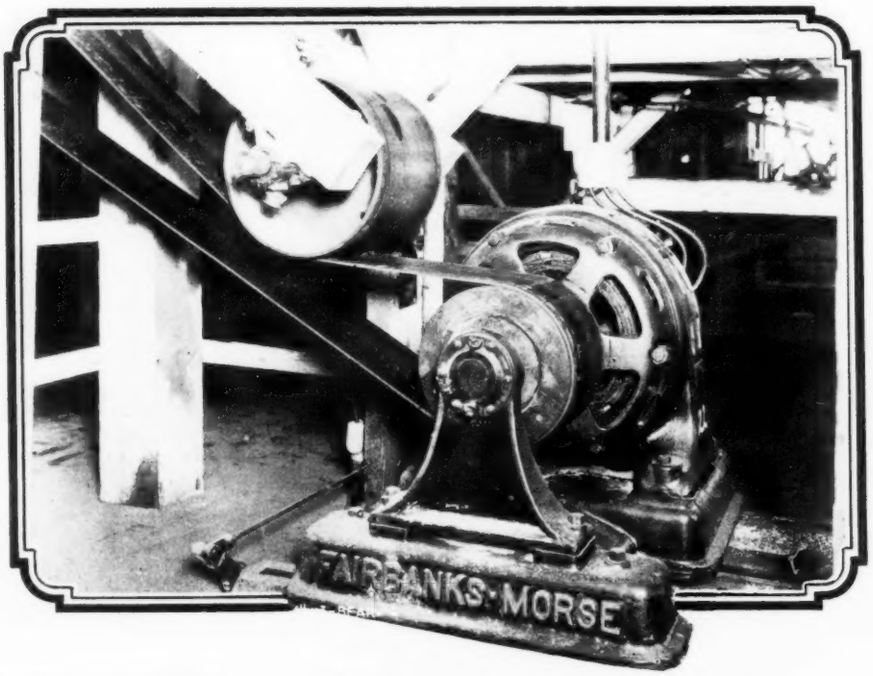
Unitype Powdered Fuel Equipment—Water Cooled Furnaces—Coal Handling Equipment—Boilers: Inclined, Vertical and Horizontal Water Tube—Boilers: Economic, Horizontal and Vertical Fire Tube —Engines: Lentz Poppet Valve Counterflow, High Speed, Variable Speed, Vertical Slide Valve—Pressure Vessels—Tanks—Grey Iron Castings.



FAIRBANKS-MORSE



Pioneer Manufacturers
OF
ball bearing motors



Unretouched photograph of 100 h. p. 720 r. p. m. Fairbanks-Morse Type "HV" 3-Bearing Slip Ring Ball Bearing Motor driving a resaw on floor above at Columbia River Saw Mills, Vancouver, Washington.

Betterments which distinguish Fairbanks-Morse Motors

- High efficiency
- Capacity for sustained overloads
- Dust-proof bearings
- Grease lubrication that prevents oil soaked insulation
- Lubricated only once a year
- No shaft wear
- Insulation that does not harden and crack
- Exceptionally rigid frame construction
- Jointless squirrel cage rotor winding

Guaranteed by
FAIRBANKS-MORSE

Capacity to spare
—for sustained overloads

Have you ever considered the importance of overload capacity from the standpoint of efficiency?

As you know, a motor is most efficient and has the best power factor when operating at its rated capacity. Yet how often motors are run below normal rating at an expensive sacrifice in power factor and efficiency just because they must be large enough to meet the occasional overload without injury!

By using Fairbanks-Morse motors, which are built to carry sustained overloads without undue heating, this is avoided. Fairbanks-Morse motors can be installed to run normally at rated load, at the highest efficiency and best power factor, without any fear that exceptional demands upon them will bring disaster.

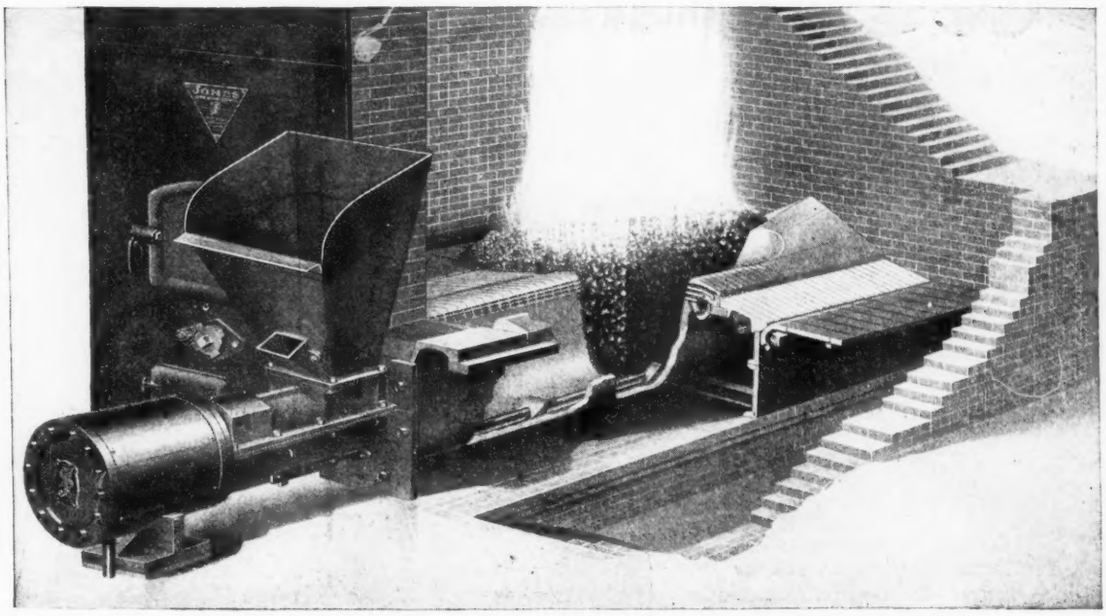
Overload capacity is but one characteristic typifying the high standards of quality maintained throughout Fairbanks-Morse motors.

Fairbanks-Morse Alternating-current motors, with ball bearings as standard equipment, are built in sizes from one-half to 500 horsepower for general purpose and special applications. Write to Fairbanks, Morse & Co., 2060 Northwestern Avenue, Indianapolis, Indiana, for complete information.

FAIRBANKS, MORSE & CO., Chicago
Manufacturers of Electrical Machinery, Oil Engines and Pumps
25 branches throughout the United States, each with a service station

FAIRBANKS-MORSE
motors and generators

Fairbanks-Morse gave the ball F M *bearing motor to industry*



The JONES "Side-Dump" Stoker

If your boilers, whether used for power or heating, or both, are between 50 and 250 h.p.—and you want a stoker that is

Easy to Clean—Easy to Install
Of Extremely Rugged Construction
Able to Carry Heavy Overloads
And Save 10 to 25% of Your Fuel Bill
(Compared with hand firing)

Investigate the Jones "Side-Dump" With its Many New and Improved Features.

A brand new Catalog, PS-8, is ready and is yours for the asking. Where shall we send it?

The Jones "Side-Dump" is made in both steam and mechanically driven types

Riley Stoker Corporation

RILEY STOKER CORPORATION

"RILEY" Underfeed Stokers
"JONES" Underfeed Stokers
"HARRINGTON" Traveling Grate Stokers
"MURPHY" Automatic Furnaces
Pulverized Coal Installations

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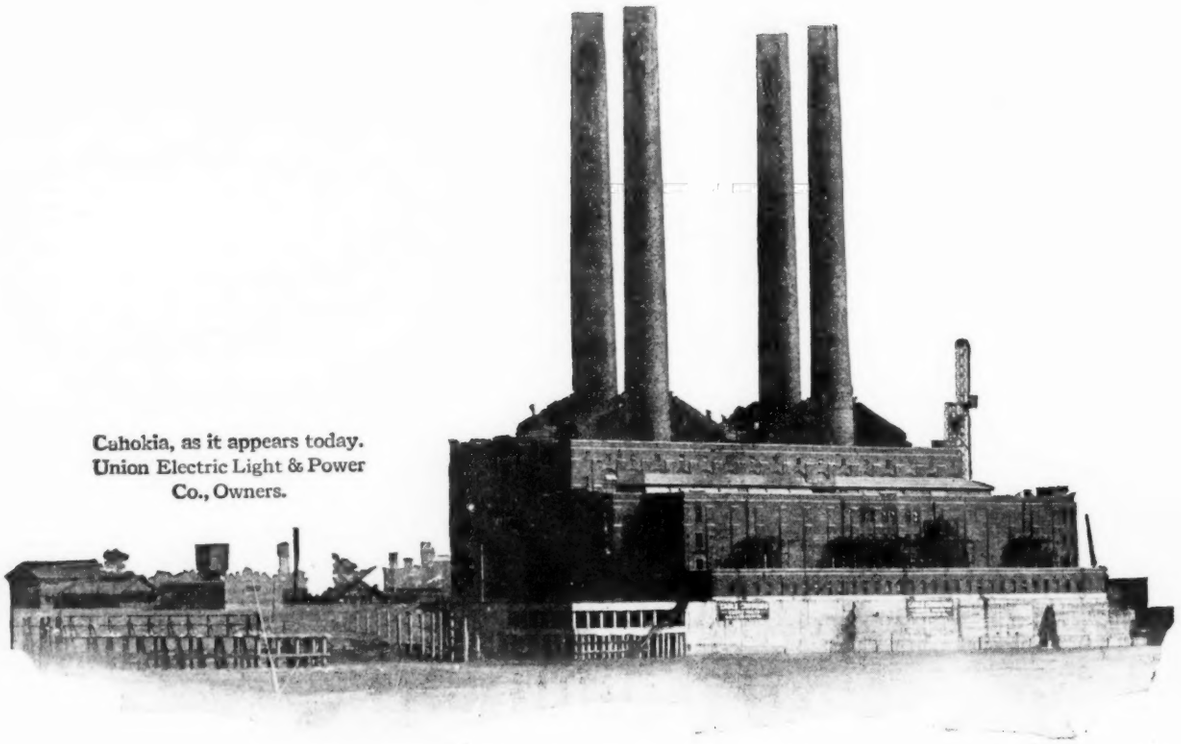
CINCINNATI CHICAGO ST PAUL KANSAS CITY DENVER CHARLOTTE DALLAS

Riley Engineering and Supply Co., Ltd., Toronto **Riley Stoker Co., Ltd., London**

Cahokia has ins



Cahokia, as it appears today. Union Electric Light & Power Co., Owners.

McCLELLAN & JUNKERSFELD

Engineers and Constructors

CAHOKIA, St. Louis' super-power plant—an outstanding success among modern generating stations—has equipped its blow-off lines and water screens with 41 Yarway Tandems and 24 Yarway Seatless Blow-Off Valves.

The boilers of the second unit are equipped exclusively with Yarway Tandems, operating under 320 lbs. pressure.

Cahokia thus offers additional evidence of the preference for Yarway Blow-Off Valves among leading engineers everywhere.

A new booklet—B-410 B—describes and illustrates all Yarway Blow-Off Valves. Write for your copy.

YARNALL-WARING COMPANY

Mermaid Avenue PHILADELPHIA

YARWAY **POWER PLANT**

YARWAY BLOW-OFF VALVES—YARWAY SPRAY

service—

41

YARWAY
TANDEM
BLOW-OFF
VALVES

and—

24

YARWAY
SEATLESS
BLOW-OFF
VALVES

Write for Booklet B-410 B—

It describes Yarway Blow-Off Valves for pressures up to 800 lbs.

DEVICES *to save fuel*

NOZZLES—YARWAY-LEA V-NOTCH METERS

Let's BUILD

build (5)—to increase and strengthen: to increase the power and stability of: to settle or establish and preserve:
—Webster

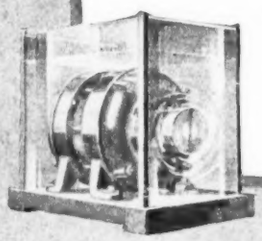
How shall we attach the feet?

There are two ways, lad, to put them on—you can either rivet them or bolt them in place.

No, pop . . .

with either method the feet will shake loose in time and customers don't want a rollicking motor.

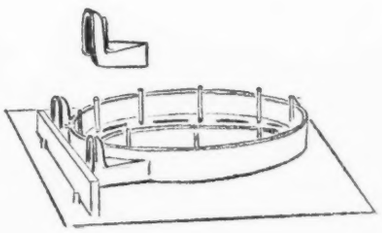
Let me sketch out for you how to BUILD (see Webster) the feet into the machine as done exclusively in the Linc-Weld.



LINC

a motor! with the Stable-Arc welder

First, you take good husky drop-forged feet. . . . . so



—and you jig them to exact place on the steel frame . . so

—and by the same Stable-Arc process which made the Linc-Weld the strongest frame in the world—you have made feet and frame one solid piece.

Now you can take a sledge and flog the duff out of such feet and you can't separate them from the frame—or break them.

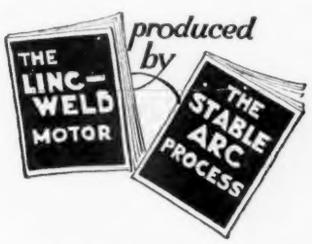
Note that the feet are welded in place always parallel to the shaft. The motor can't rock when mounted on a true base.

This is but one of a dozen cases in building the Linc-Weld motor where the Stable-Arc has worked for the motor buyer. It has given him a stronger construction and saved us enough money to give him extra strong insulation and higher cost windings.

You can think of a number of places in your work where the Stable-Arc will give you the same short cut to better construction. Read the book on the right.

Illustrated answers

Realizing that the news value of the new process motor, as well as the process by which it is constructed, will naturally bring up many questions—two very completely illustrated volumes have been prepared thoroughly covering the subjects:



These books are in envelopes ready to be sent by return mail to all persons requesting them.

For your convenience in getting your copies—simply pencil in your address on the coupon below.

The Lincoln Electric Co.

Cleveland, Ohio

C-WELD

COUPON

To The Lincoln Electric Co., Cleveland, Ohio

Please send to Mr. .....

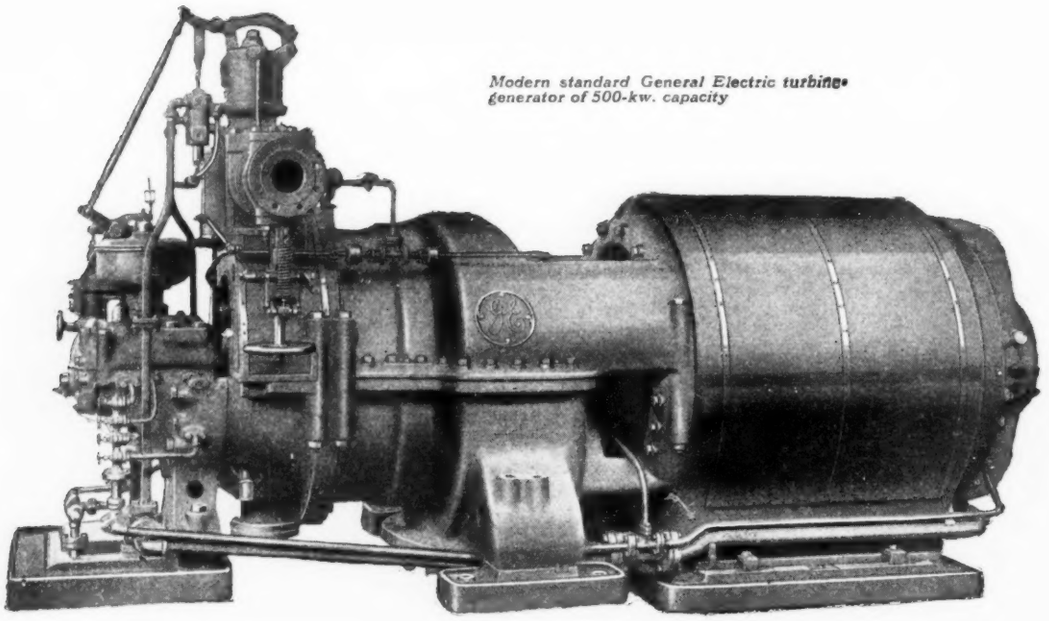
Company .....

Address .....

.....

The Motor Book ☐
The Stable Arc Process Book ☐

2-12-29



Modern standard General Electric turbine-generator of 500-kw. capacity

9 years of continuous service

In a letter from Walter Schoonmaker, of the Cambria Fuel Company, Wyoming, regarding their 500-kw. mixed-pressure G-E Turbine-Generator:

"After starting this equipment in June, 1913, it was operated practically continuously until April, 1922, when we installed our 300-kw. unit. The cause for this continuous operation (day and night) came about through the fact that the 500-kw. equipment was the only unit we had and was used in connection with our coal mining operations and the lighting of the towns of Cambria and New Castle, Wyoming, thereby giving 24 hours service per day.

. . . . . .The turbine was never opened until during the strike in 1922, when it was gone into, and the buckets and nozzles were found to be in excellent condition. . . . . .

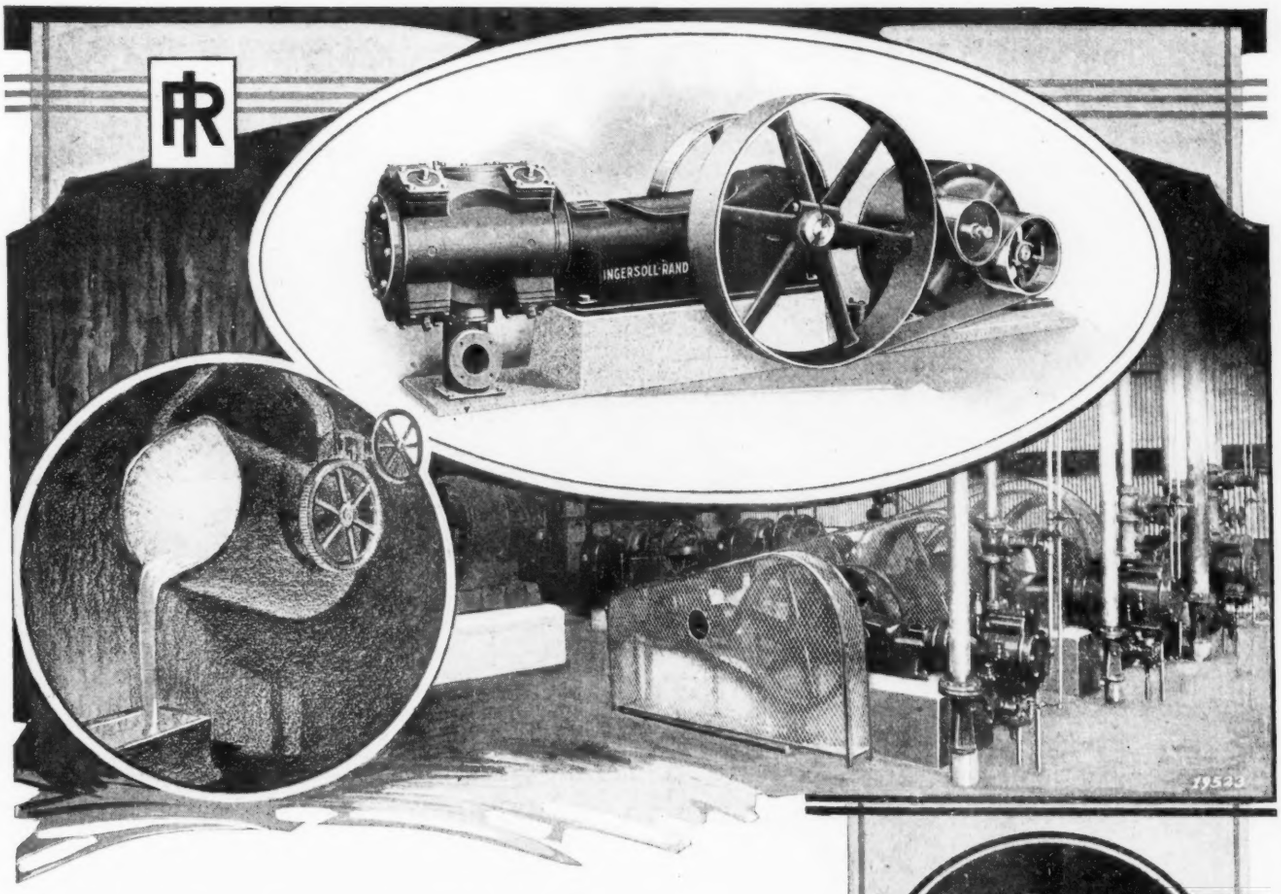
. . . . . .no bearings have ever been replaced or rebabbitted or any other trouble experienced. It is therefore a great pleasure to us to inform you of the most satisfactory service that this equipment has given and is still giving us."

Such performance of G-E Turbines results from the experience and knowledge that G-E turbine engineers have acquired during their long association with the industry—and that every G-E Turbine embodies. Either as generating sets or for mechanical drive, General Electric Turbines are Good Turbines.

6B-8

GENERAL ELECTRIC

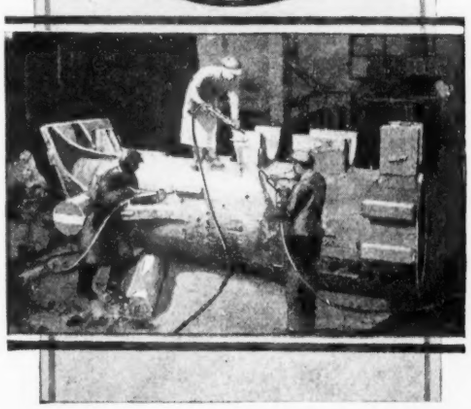
GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES



Foundry Service Eliminates All But the Sturdiest and Most Reliable

To stand up under foundry demands and give continuous, satisfactory, day-in-and-day-out service, pneumatic equipment must have sturdiness and reliability built into it from start to finish.

This is one of the reasons why Ingersoll-Rand Class "ER" Air Compressors and Ingersoll-Rand Pneumatic Tools are so universally chosen by the Casting Industry. *These machines are sturdy. They are reliable.* They are designed, built, sold, and serviced by an organization with a background of more than a half-century of experience with compressed air equipment.



Class "ER" Compressors and a complete line of I-R Pneumatic Tools are available for prompt shipment from one of the I-R Service Stations near you. Request Bulletins No. 3050 and No. 8000.

INGERSOLL-RAND COMPANY-11 BROADWAY NEW YORK CITY
Offices in principal cities the world over
FOR CANADA REFER CANADIAN INGERSOLL RAND CO LIMITED 260 ST JAMES STREET MONTREAL QUEBEC

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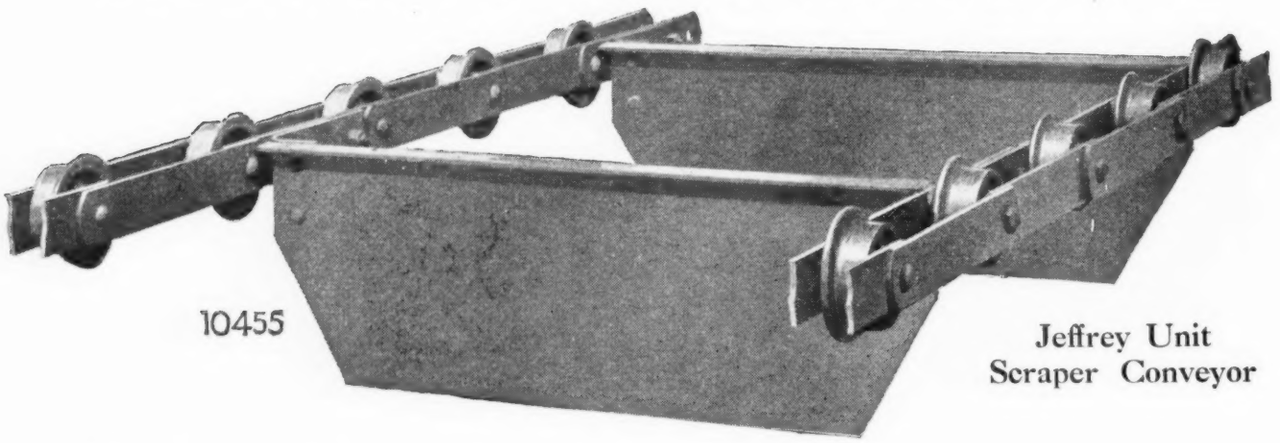
Ingersoll-Rand

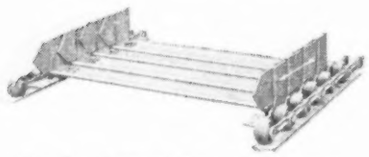
Dependable Service

With Low Cost of Installation and Operation



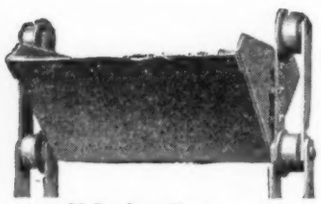
Jeffrey Unit
Scraper Conveyor

Other Types of Jeffrey Unit Conveyors

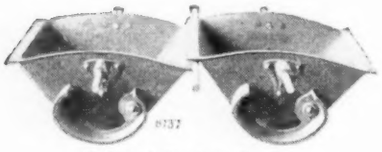


Steel and Wood Apron Conveyors

Belt Conveyor



V-Bucket Conveyor



Pivoted Bucket Carrier

JEFFREY Standard Unit Scraper Conveyors, both Single and Double Strand Types, are designed to handle many kinds of loose products of the farm, manufacturing and mining industries, with their widest application being for the handling of coal and similar semi-abrasive materials.

Wide Range of Service — May be installed on the horizontal, or an incline, or as a combination in one conveyor of both horizontal and incline.

Simple to Install — Readily inspected — Low upkeep and power consumption — Easily repaired.

The many pages of instruction, specifications and dimensions in Catalog No. 257-E on Jeffrey Standard Scraper Conveyors have been compiled in such a way that the engineer, and often the purchaser who is unfamiliar with engineering knowledge, may easily select the right conveyor to fit his needs. Write for a copy.

The Jeffrey Manufacturing Company

932-99 North Fourth St., Columbus, Ohio

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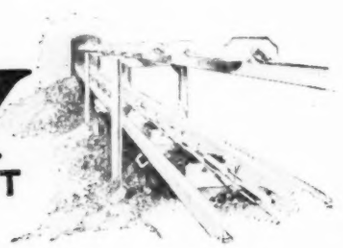
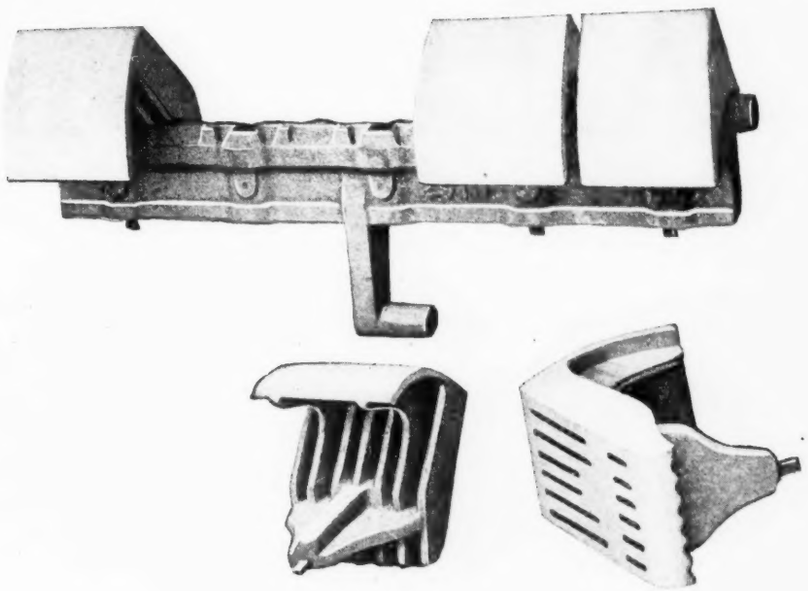
JEFFREY
MATERIAL HANDLING EQUIPMENT



McClave

Hand Stokers

for Bituminous, Coke Breeze, Lignite

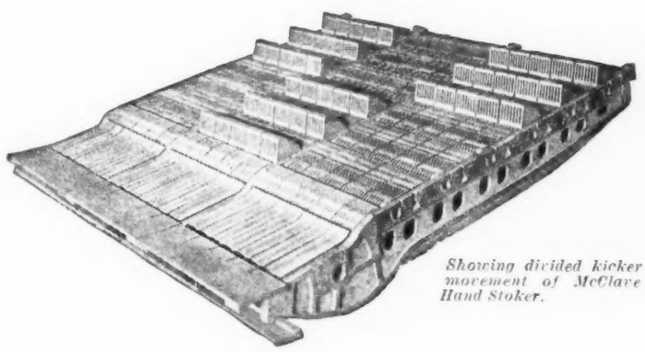


Holding down maintenance cost by sheer weight

Notice the full dimensions on these grate bars and tops. Notice the thickness of metal—in top sections, ribs and reinforcements generally—put there to absorb the otherwise destructive expansion stresses, so often a big cause of high maintenance.

And still with these extra heavy grate bars, operation is easy in McClave Hand Stokers. It is a simple matter of leverage. Note the grate bar lug, extremely long and manifestly powerful. It takes the labor out of hand operation.

A surprising number of small plants are securing close to mechanical stoker economies with low first cost, by the use of McClave Hand Stokers. Write us for details on this or any other hard fuel combustion condition which may affect you.



Showing divided kicker movement of McClave Hand Stoker.

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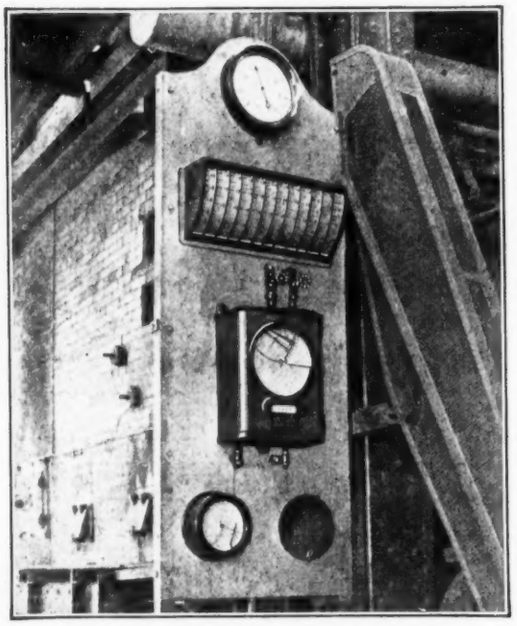
McClave GRATES STOKERS STEAM BLOWERS

McClave COMBUSTION SYSTEMS *for greater economy*

BAILEY METERS

Used by Leaders in Every Industry



Boiler Panel Board on one of the boilers in a large oil refinery in the East.

A Few Oil Refineries Where Numerous Bailey Meters Are Used

Atlantic Refining Company
Empire Refineries, Inc.
Humble Oil & Refining Company
Marland Refining Company
Midwest Refining Company
Mutual Oil Company
The Paraffine Companies
Paragon Refining Company
Pure Oil Company
Sapulpa Refining Company
Shell Company of California
Sinclair Refining Company
Standard Oil Company
The Texas Company
Vacuum Oil Company

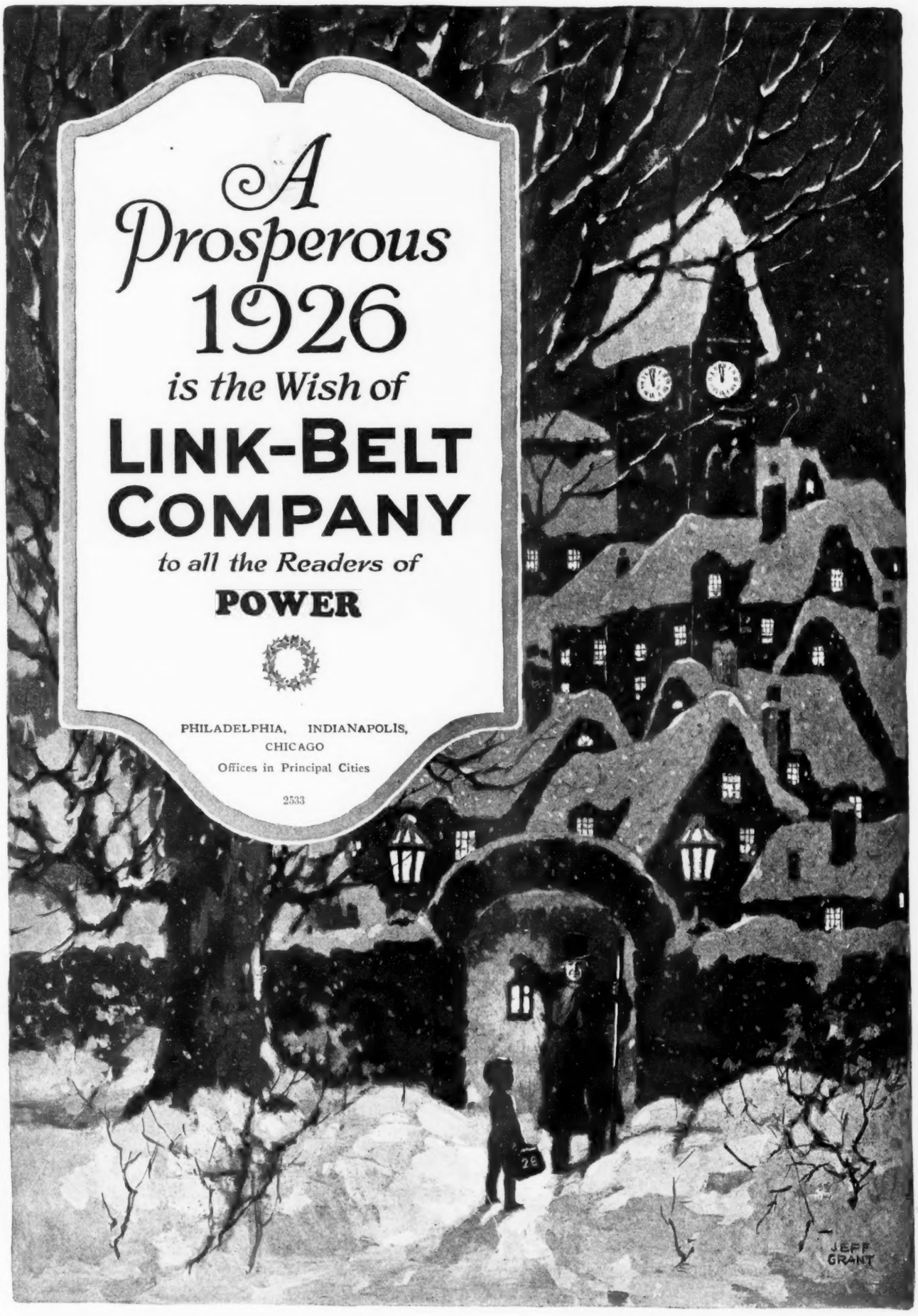
Every power plant engineer is vitally interested in power plant efficiency and anxious to adopt ways and means of increasing the economy, as well as the capacity, of his plant with the least expenditure. The first step is to locate and determine the magnitude of the losses so as to be able to reduce them to a minimum and thereby improve the final results.

You can determine the fuel and stack losses, as well as check the fuel, steam and water consumption by the use of Bailey Meters.

Practically all of the central stations and the largest power users throughout the country are controlling boiler operation by the aid of Bailey Boiler Meters and Multi-Pointer Gages.

Our bulletins are free for the asking

Write for Bulletin No. 81
"The Heat Balance in Steam Power Plants"


A Prosperous 1926
is the Wish of
LINK-BELT COMPANY
to all the Readers of
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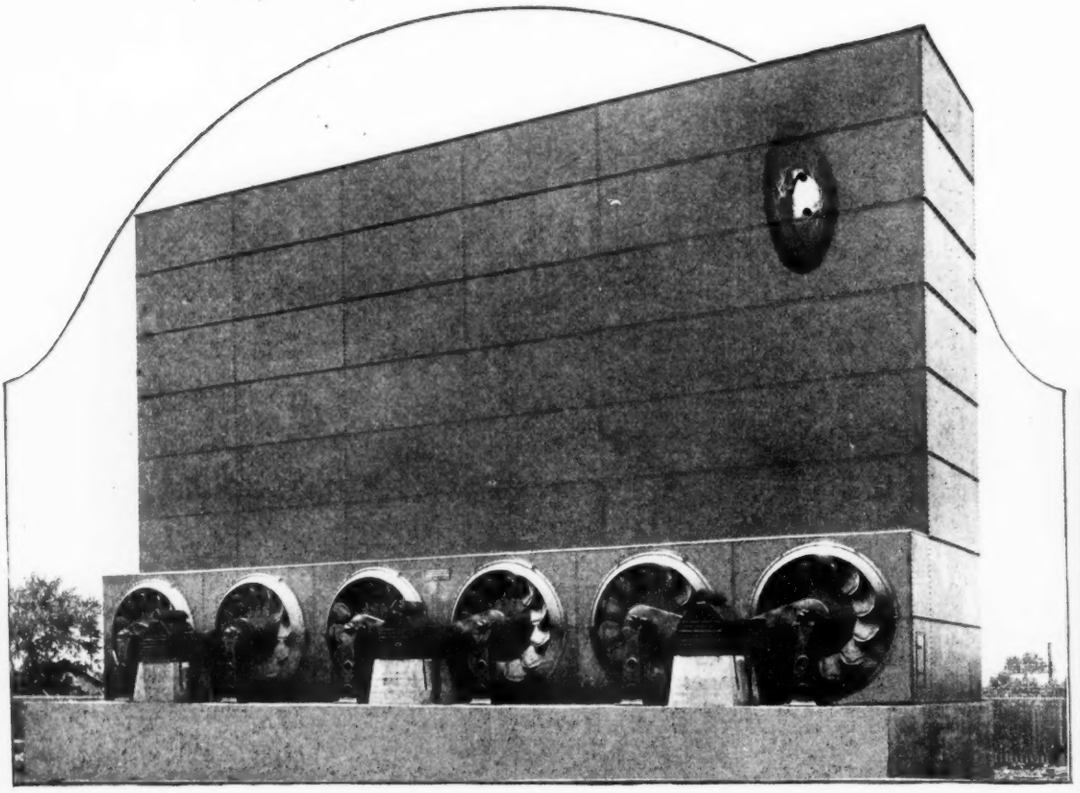
PHILADELPHIA, INDIANAPOLIS, CHICAGO
Offices in Principal Cities
2533
JEFF GRANT



A three-unit C. H. Wheeler Forced Draft Cooling Tower

A C. H. Wheeler Product—

Ford Motor Co. buys— ten C. H. Wheeler Cooling Towers

Each unit will have a capacity of re-cooling 1000 gallons of condenser water per minute, with the aid of two forced draft fans, both located on one side.

High cooling efficiency is called for in contract for these towers.

They will be located at Dallas, Louisville, Memphis and Charlotte—where the summer months are very hot and humid.

C. H. Wheeler Cooling Towers are furnished in three general types—forced draft—natural draft, with open louvers—and combined natural and forced draft.

Our engineering department has special cooling tower data relative to re-cooling water—regardless of location or quantity required. *Write for information.*

C. H. WHEELER MFG. CO.
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Ask C.H.Wheeler of Philadelphia about

Surface Condensers
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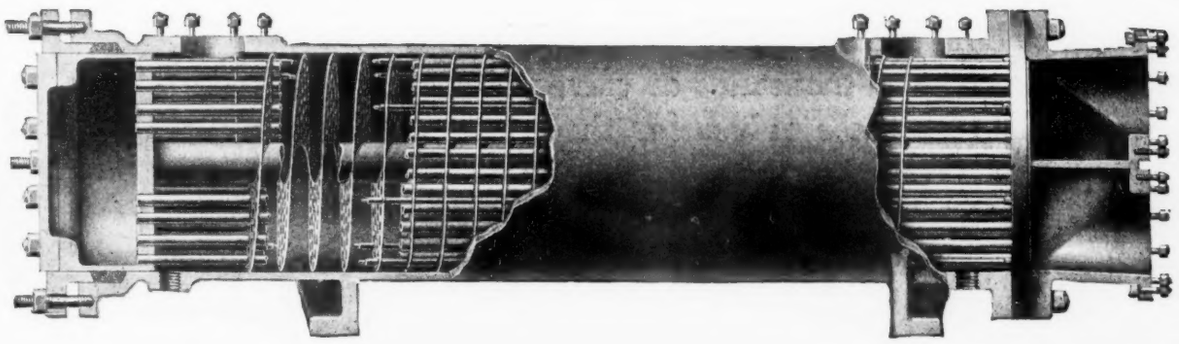
"C.H.Wheeler of Philadelphia"

Prevent Overheated Turbine Bearings



G-R Multiwhirl Coolers

Keep turbine bearing and reduction gear oil at the temperature for proper lubricating effect. They reduce the lubricating oil consumption as well as protect the bearings.

Over 2000 In Use

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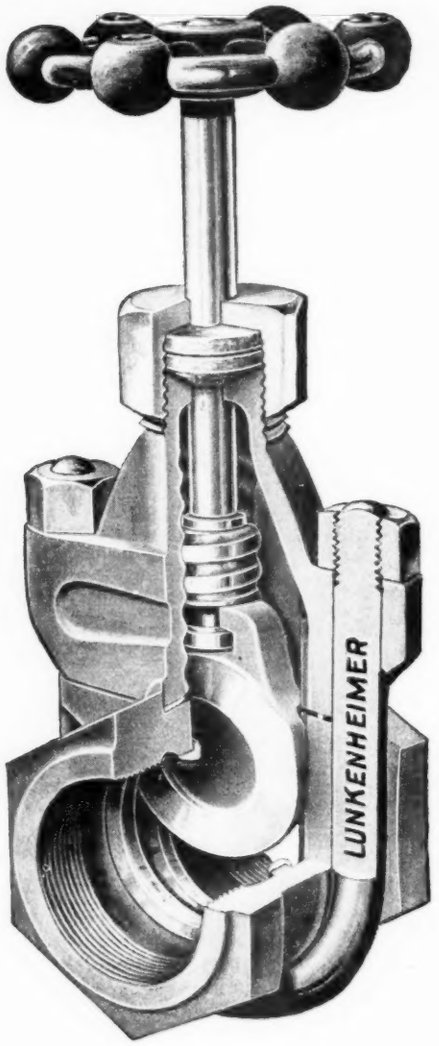
P. 12-29-25

It's the Extra Measure of Service

rendered by Lunkenheimer "Clip" Gate Valves which has influenced thousands of valve users to standardize on these valves for their low pressure lines. And the number is being augmented daily by others who insist on getting the genuine

LUNKENHEIMER "Clip" GATE VALVES



Simplicity of design, sturdy construction, easy accessibility and renewability of all parts combine to make the "Clip" the ideal, economical valve for steam, oil, or water service, where pressure does not exceed 100 pounds at 450° F.

Withstand not only the pressure and temperature for which they are recommended, but also the stresses caused by expansion, contraction, vibration, weight and settling of the pipe, and other severe service conditions.

Iron Body Bronze Mounted Pattern is regularly furnished; but also procurable with lever for Quick-Operating purposes, and in the All-Iron Pattern for handling fluids which attack bronze but not iron.

Distributors, located in all commercial centers, carry Lunkenheimer Products in stock and render prompt service. Call on them for your requirements.

Detailed information is contained in booklet 505; a copy will be sent without obligation.

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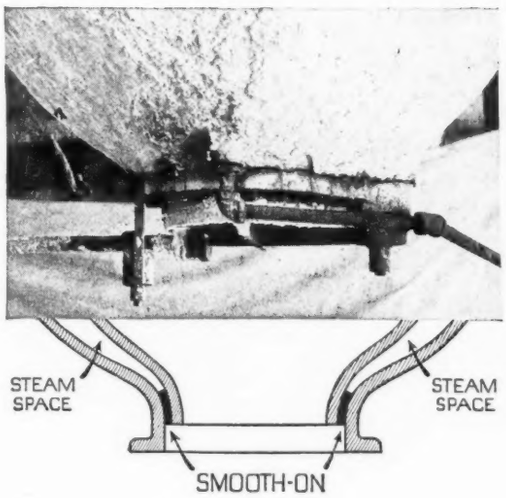
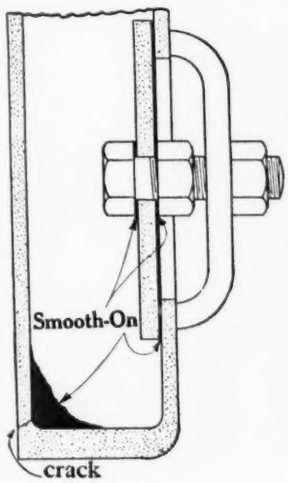
Repairing leaks in steam or water jackets



This steam kettle dropped during erection at a plant in Jersey City, N. J., and sprung a leak at the bottom joint. All attempts to seal the break failed until SMOOTH-ON No. 1 was applied. The SMOOTH-ON repair remained perfectly tight after two years' constant service under 60-lb. jacket pressure.

WHAT SMOOTH-ON No. 1 can do for leaks at seams, joints or cracks in steam jackets is indicated in the two illustrations.



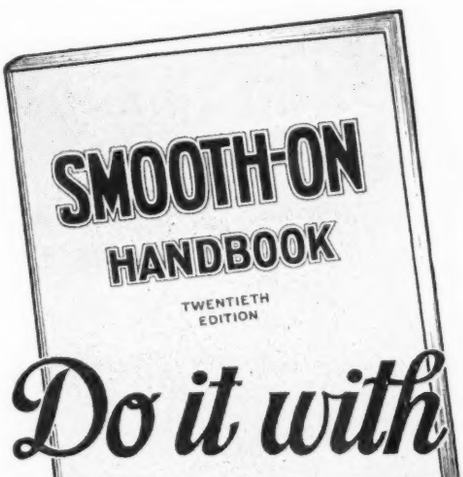
The one at the right refers to three meal cookers in Rock Hill, S. C., which were badly cracked at the mouth where the cooked meal was drawn out. Patches could not be put on the outside, so a handhole was cut through the outside casting into each steam jacket, to reach the seat of the trouble. After thoroughly cleaning all cracks, SMOOTH-ON No. 1 was forced into them. After that hardened, the whole corner was heavily filleted with SMOOTH-ON No. 1 as shown and hand-hole plates with studs were fitted over the new outside holes. On starting, these jackets were perfectly tight and stayed so for eight years.

The builders of the cookers failed to give satisfaction and could not suggest repair methods when the trouble developed. The engineer remembered SMOOTH-ON No. 1 from past experience and tackled the job on his own initiative. His ingenuity together with the valuable properties of SMOOTH-ON saved the investment from what appeared to the owners to be a total loss. Water jackets also which have cracked or even had pieces drop out from bursting, freezing or fire have been restored with the same success with SMOOTH-ON No. 1.

Many practical methods for such repairs are explained and pictured in the SMOOTH-ON Handbook, which will be sent free on request.

The SMOOTH-ON HANDBOOK FREE if you return the coupon

Twentieth Edition—Completely rewritten—136 pages of new data—193 diagrams, pictures and practical hints on at least 200 different uses for SMOOTH-ON. Every progressive engineer should have this book—get your copy NOW.



Get SMOOTH-ON *No. 1 in 1 or 5-lb. can or 25, 50 or 100-lb. keg from your nearest dealer, or if necessary from us direct.*

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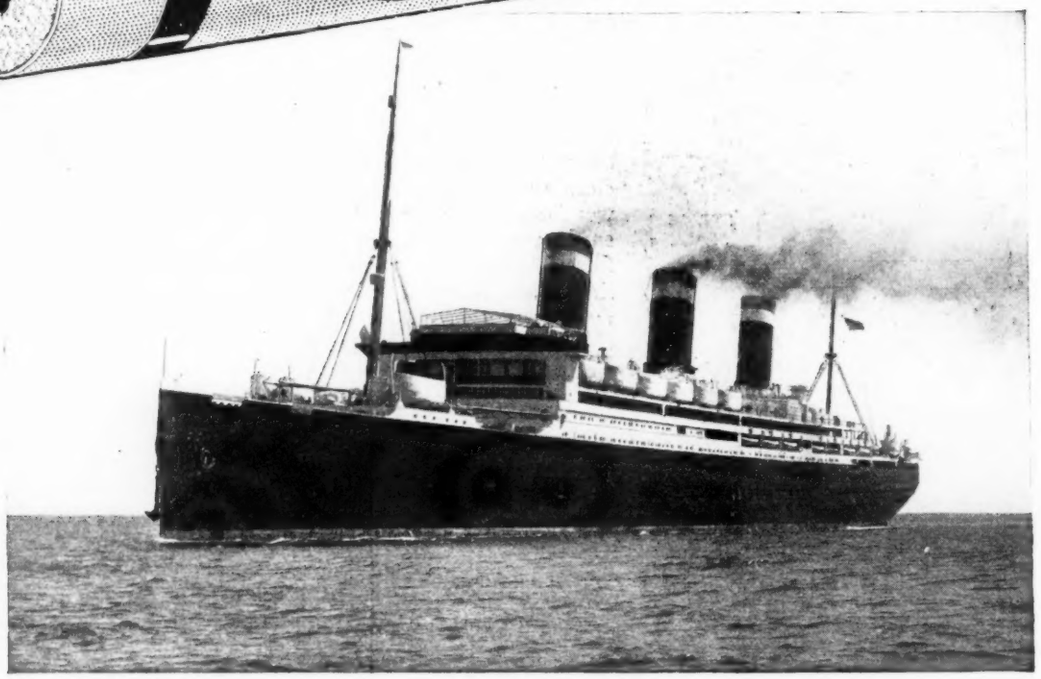
Dept. 30, 570 Communipaw Ave., Jersey City, N. J.
Please send copy of the SMOOTH-ON HANDBOOK, 20th Edition.
Name .....
Address .....
..... Power

Do it with

SMOOTH-ON



America's Greatest Ship

Conserves Fuel by Better Heat Insulation

All high pressure steam piping on board the U.S.S. "Leviathan" are covered with K & M FEATHERWEIGHT 85% Magnesia Covering—proved "best by test" by competent engineers.

The selection of the right pipe and boiler covering is of vital importance. By minimizing radiation losses, much valuable fuel can be saved. The saving easily pays for the difference in cost between poor and good insulation several times over during a year.

K & M FEATHERWEIGHT 85% Magnesia Boiler and Pipe Covering contains the full 85% carbonate of magnesia, combined with carded Canadian asbestos fiber. It is the lightest pipe covering made. It has never been exceeded in heat insulating value and durability. Age actually improves it.

Tell us what pressure and superheat you carry and we will recommend the right thickness for K & M 85% Magnesia Covering. No obligation for consultation or cost estimate. ***Write for Catalog.***

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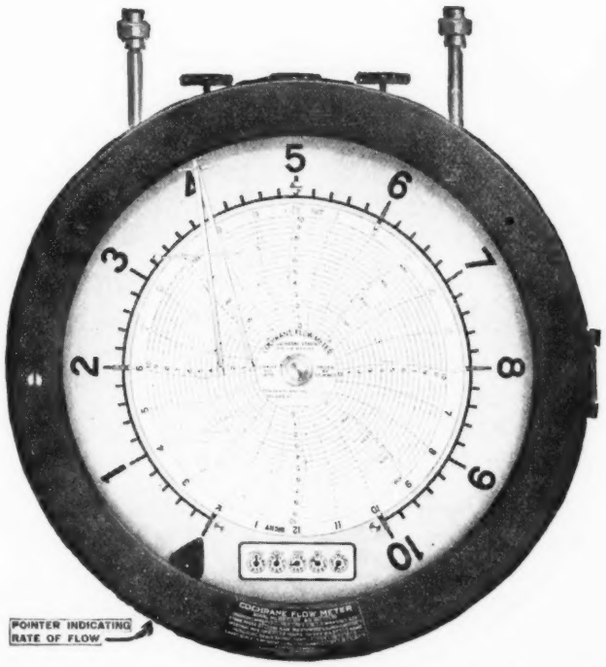
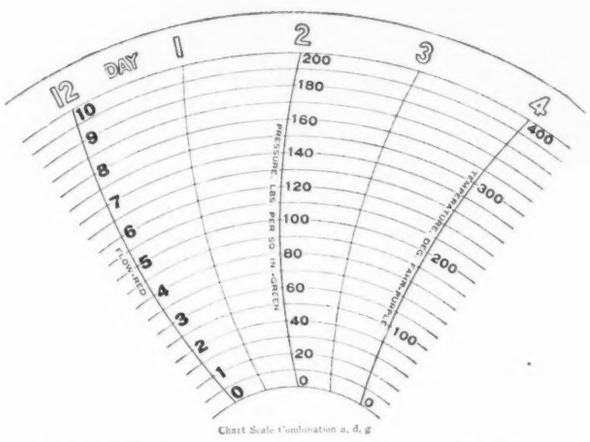
A Complete Flow Meter



Cochrane Indicating, Recording and Integrating Flow Meter with Cochrane Recording Pressure Gage



Portion of Cochrane Flow Meter Chart Showing Pressure and Temperature Scales

THE correct weight of water, steam or air can be determined from a flow meter record only if you know the pressure or temperature, or both. This information is supplied by the

COCHRANE

Integrating, Recording and Indicating

FLOW METER

with combined pressure and temperature recorders

The pens of the temperature and pressure units rotate about the same axis with the flow pen and use the same scale, which has evenly spaced graduations. The even spacing is a great convenience, not only when integrating the charts for obtaining average values, but also in reading the charts, as there is no misleading distortion.

The illustration shows a Cochrane Flow Meter with a pressure element added, while the sample chart is for a meter fitted with both temperature and pressure gages.

Send information regarding the nature and temperature and pressure limits of the fluid to be measured, and the proposed location of temperature element, if used, so that we may submit recommendations, estimate and accuracy guarantee.

Ask for Catalog L-1247.

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FORMERLY HARRISON SAFETY BOILER WORKS

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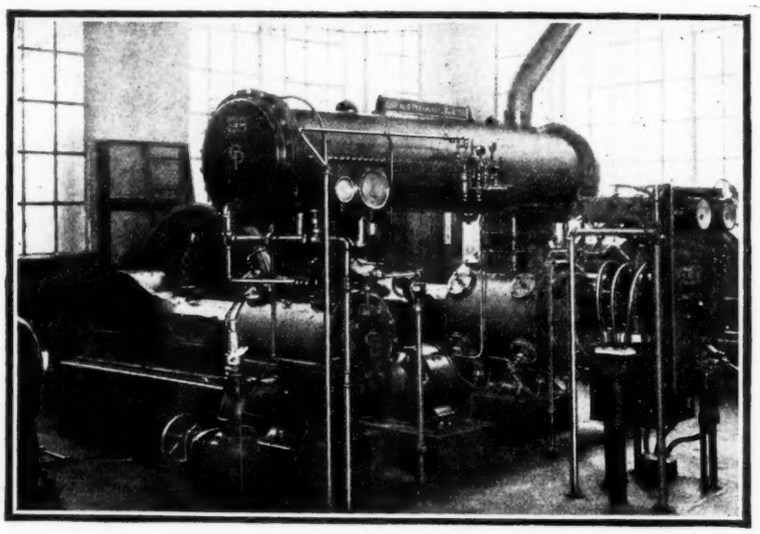
316



Chicago Pneumatic Two Stage, Direct Mounted, Motor Driven Air Compressor

For Compressor Economy Year after Year

THE 1000 cu. ft. Chicago Pneumatic Compressor shown above was installed in the plant of a large Michigan manufacturer on June 10, 1922. Since that time, a period of over three years, this compressor has been in constant operation and only $22.00 has been spent on new parts.

When advising a western railroad of the performance of this compressor, the Owner's Maintenance Engineer said, "The Chicago Pneumatic Air Compressor has proven very satisfactory to date, eliminating all valve trouble."

This is typical of the steady and economical performance rendered by CP Portable and Stationary Compressors which are supplied in steam, oil, belt or direct motor driven types to meet all requirements.

For full information write for Bulletins.

Chicago Pneumatic Tool Company

6 East 44th Street, NEW YORK, N. Y.

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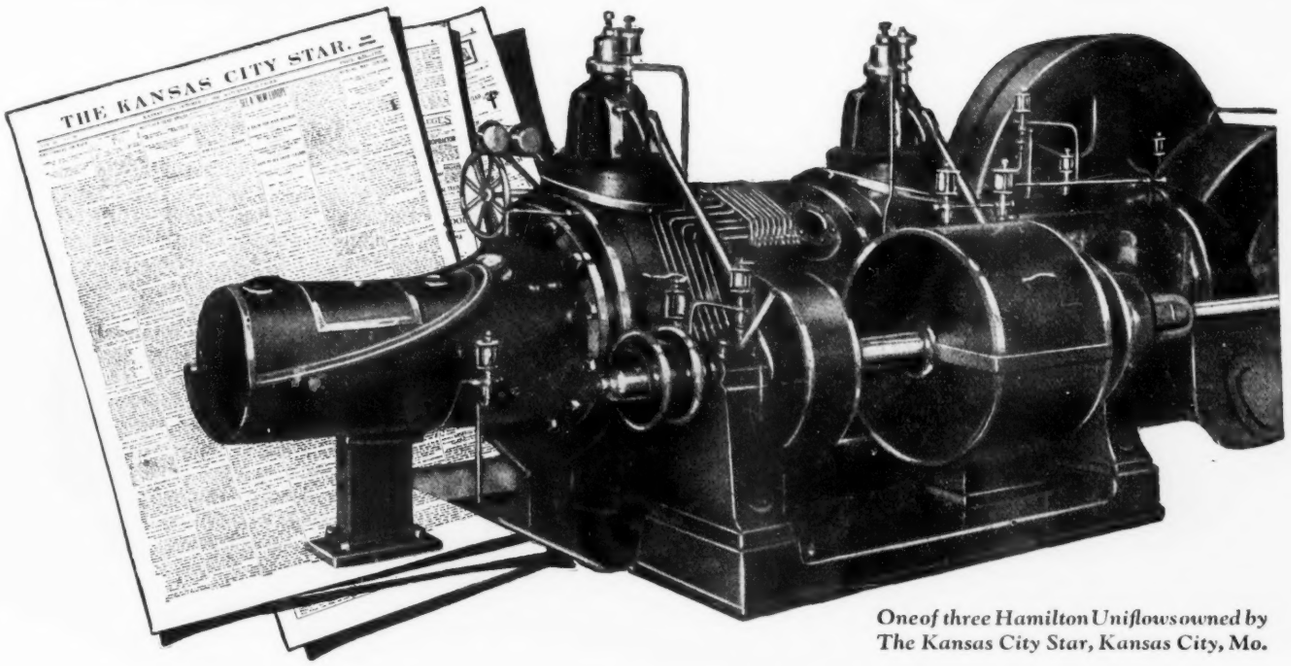
C-196

BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

CHICAGO PNEUMATIC

Depend upon *that Name*



One of three Hamilton Uniflows owned by The Kansas City Star, Kansas City, Mo.

Living up to The Star

No other paper in the world is read with more confidence than the Kansas City Star. Not one is more *dependable.*

The fact that the owners of the Kansas City Star use three Hamilton Uniflows is one of the greatest tributes to this engine. Everything in the magnificent Star plant is the finest of its kind in the judgment of the men who direct the Star. And they are noted for their good judgment.

The quality possessed in common by the Star and Hamilton Uniflows is absolute *dependability.*

It is a quality that should impel you to find out about Hamilton engines whenever you need power equipment.

Hamilton Products

CORLISS ENGINES
POPPET VALVE ENGINES
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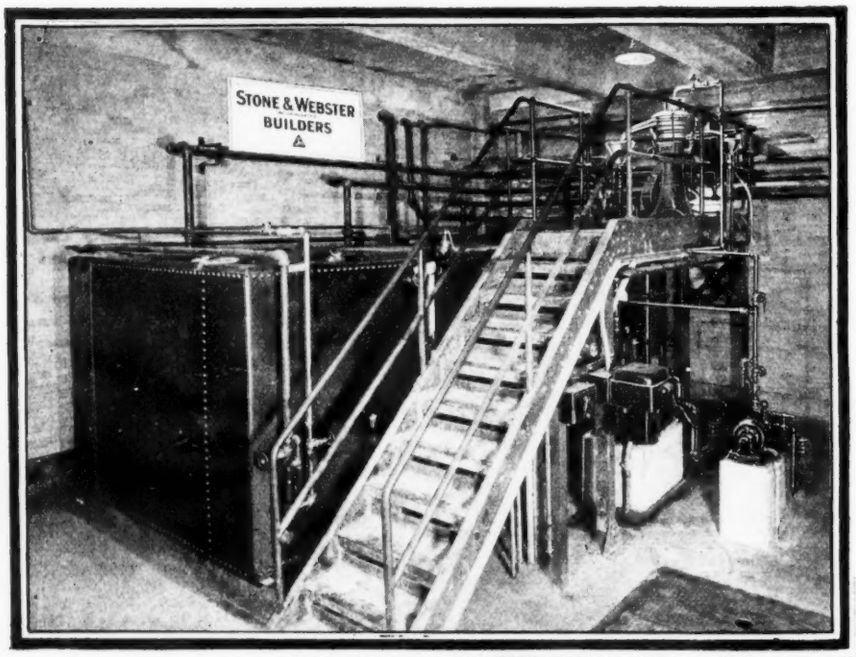
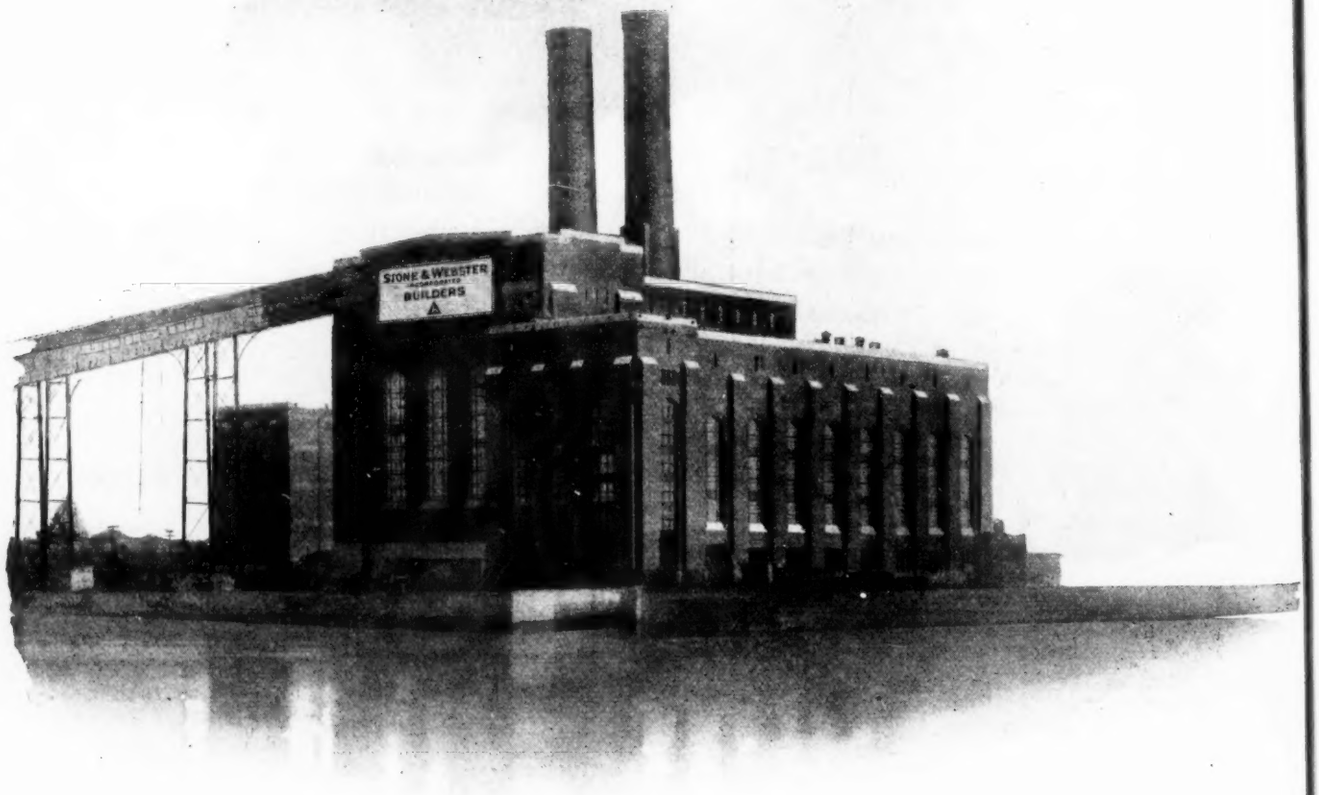
THE HOOVEN, OWENS, RENTSCHLER CO.
Engine Builders since 1845 HAMILTON, OHIO

HAMILTON
Engines *and* Machinery

Why Stone & Webster Specified D



The De Laval Oil Purifier shown in this illustration cleans the oil used in the lubricating systems of the two 30,000-kw. turbo-generators, now installed at Edgar Station.



De Laval Purifiers for Weymouth
(NOW EDGAR)

The new 67,000-kw. Weymouth Station (now known as Edgar Station) of The Edison Electric Illuminating Company of Boston, as shown in the illustration, is but the first step in the construction of a plant which will ultimately generate 500,000 to 600,000 kw. Plans for a station of this capacity must of necessity discount conditions which may develop many years in the future. Hence, in designing and building the Edgar Station, Stone & Webster, as well as the engineers of the operating company, have followed their policy of specifying the most advanced types of equipment.

De Laval Oil Purifiers

have been installed to maintain the efficiency of turbine lubricating oil, transformer and switch oils. These oils play an extremely important part in the continued dependable and economical operation of any power plant, and De Lavals have been selected to keep them clean at Edgar: First, because Stone & Webster have had ample opportunity to study their performance in other plants they have built or are managing; and, second, because The Edison Electric Illuminating Company's engineers have been able to study the results of their operation for a period of years in other of their own plants.

One De Laval Oil Purifier cleans the oil used in the lubricating systems of the two 30,000-kw. turbo-generators now installed at Edgar, while another — a Transformer Oil Purifier of the portable *Conservator type*—is used to maintain the dielectric strength of insulating oils. The latter machine is convertible so that it may be operated as a non-aerating unit to dehydrate oil in transformers with the conservator attachment or as a regular Transformer Oil Purifier for all other work.

De Laval centrifugal purification is the most positive oil conditioning method known. In the matter of removing moisture from turbine or transformer oil it is without a serious competitor, either as to thoroughness of dehydration or economy of operation. In the removal of sludge from either of these oils, or carbon from switch and circuit breaker oil, it is equally positive and economical, instantaneously removing from the oil passed through it all but the merest trace of impurities.

No wonder that De Laval Purifiers are now used by 80% of the largest electric power systems in America, and no wonder that hundreds of smaller systems and industrial plants have adopted them as a means of getting longer and better service from the oil they use.

The De Laval Engineering Department will be glad to cooperate with you in order that you may have the same kind of lubricating and transformer oil which keeps all of these systems operating so smoothly. We have interesting proof of the savings in machinery, oil and labor that can be made. Mail the coupon for further information.

The De Laval Separator Company

NEW YORK
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De LAVAL PACIFIC COMPANY
San Francisco

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- ☐ Purification of turbine lubricating oil.
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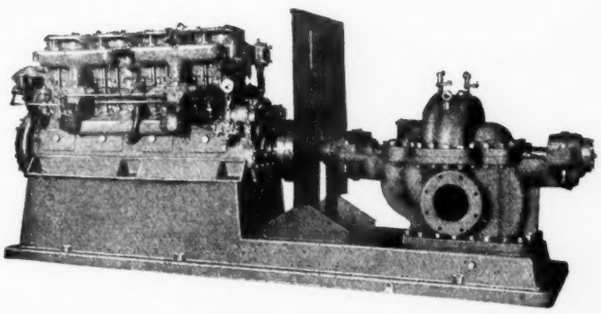

One of two units at West Palm Beach, each consisting of 8" American Well Works pumps, 1500 G. P. M. 320 ft. head, 1350 Revs., driven by straight 8 cylinder 240 H. P. STERLING engines.

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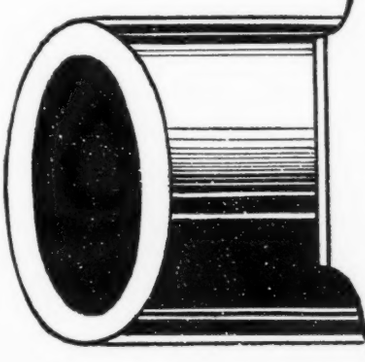

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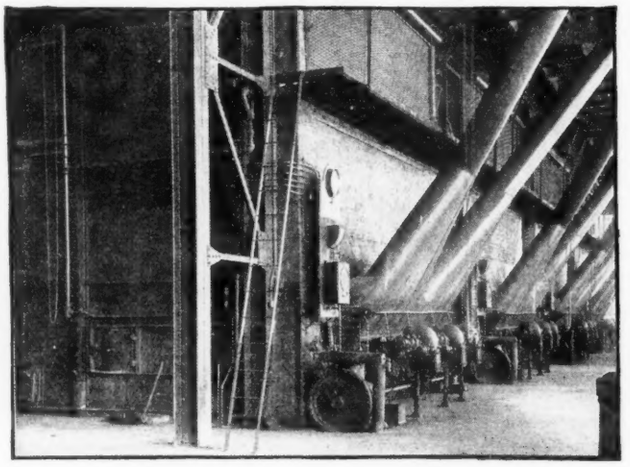

WHETHER it be in a 200,000 k.w. central station or a 300 h. p. manufacturing plant, the boiler plays a vital part in determining the final margin of profit. Competition dictates strictest economy—the economy of increased efficiency—and where can its precepts be better applied than in the power plant?

Edge Moor Boilers have proved their ability to meet the conditions imposed on modern power plants.

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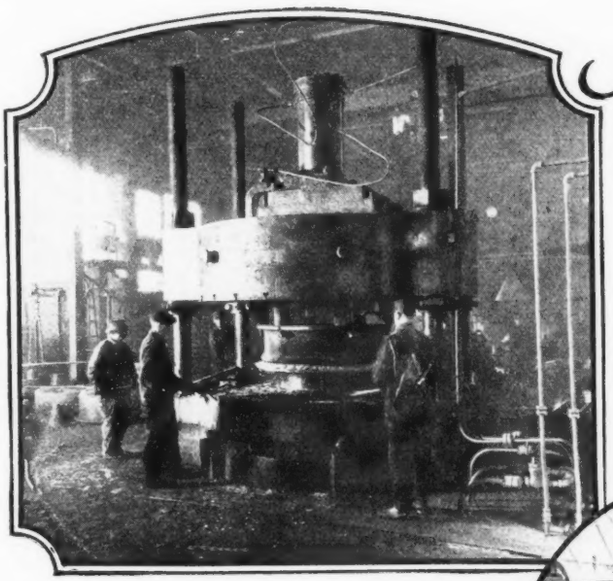
EDGE MOOR Water Tube BOILERS

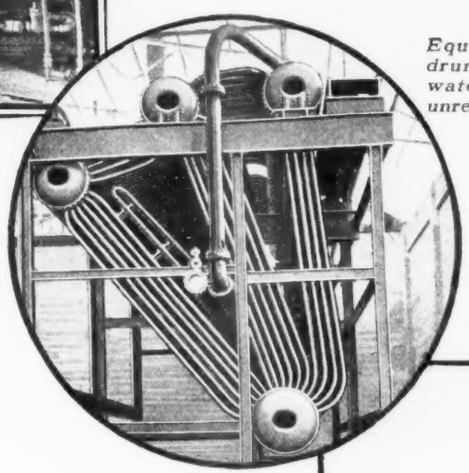
FOR INCREASED FUEL ECONOMY



The 500 ton flanging press that produces Connelly boiler heads by a single application.

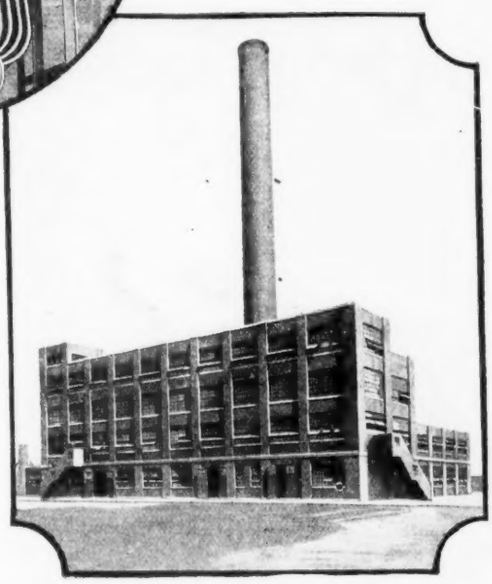
Making Connelly Boilers The BEST

The danger of unequal strain in different parts of the same head is overcome by flanging and dishing all drum heads in one operation.



Equal tube area between drums in the path of the water provides free and unrestricted circulation in Connelly boilers.

A typical Standard Oil Power House. 20 Connelly boilers of 9700 horsepower are used by this company in five different localities.



THE tendency toward larger units and increased pressure has been met by Connelly with a number of innovations in boiler construction.

Drum heads are flanged and dished in one operation at the Connelly plant instead of being heated and flanged in several different sections.

Improved manufacturing processes have thus made feasible the production of efficient, economical boilers of the patented Connelly design in units of from 200 to 3000 h.p. and for steam pressures up to 400 lbs.

A fully explanatory catalog will be sent promptly on request.

The CONNELLY BOILER COMPANY

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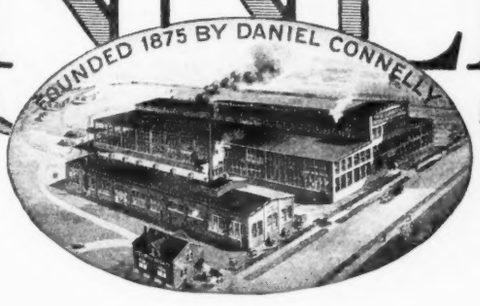
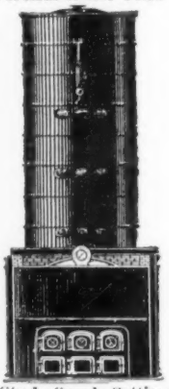


Vertical Water Tube



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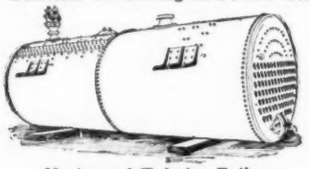

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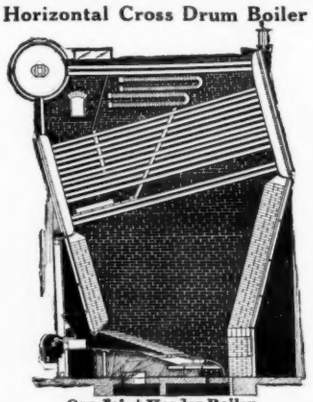

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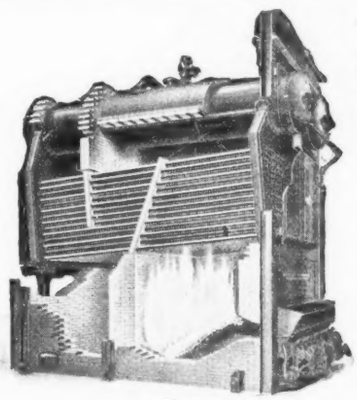

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Semi-Inclined,
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HIGH overload capacity coupled with quick steaming factors enable Union Water Tube Boilers to cope with peak demands.

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Tube scaling is minimized, due to the self-contained feed water purifier.

The new catalog gives full details.

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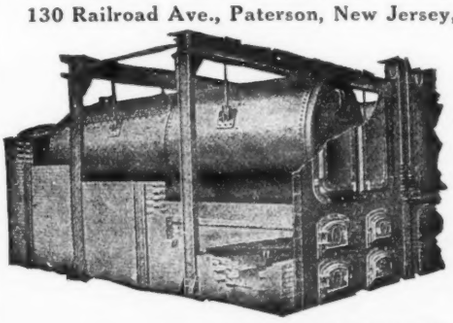

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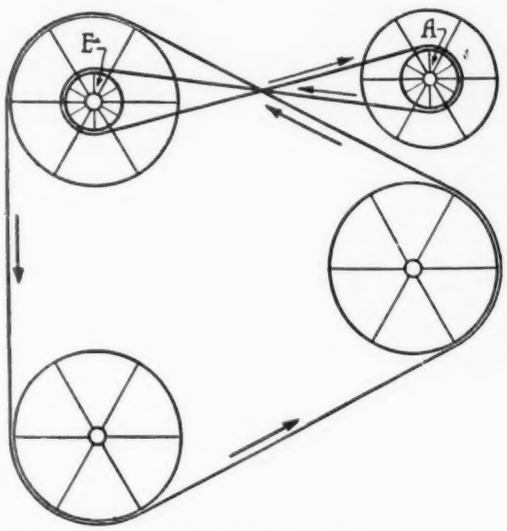
Two-Flow
Ring-Circuit Boiler

embodies the most important advance made in boiler design during the last 30 years.



THE *main circuit* which does the receiving of the feed and the evaporating of the water is analagous to the big belt passing over the three large pulleys in the figure.

The difference between this and every other design is that this circuit has nothing to do with the controlling of the equality of water level in the top drums!

The *controlling* is done by an entirely separate water circuit represented diagrammatically by the crossed belt over the two smaller pulleys.

This Supplementary Circuit Does Control

and forever banishes from boiler design any further necessity for widely different water levels in the top drums.

We back up this statement by a stiff penalty and bonus guarantee

Further, the Kidwell Boiler delivers—

Steam superheated 25 to 60 degrees;
Steam which is CLEAN,
And this boiler can without any detriment be operated at ratings impossible with other designs.

Write us for proof of every statement above made, and many more. Ask for a copy of our book, which is *not a catalog in any sense*, but the most complete treatise on water tube boilers ever issued. It will be sent free to engineers.

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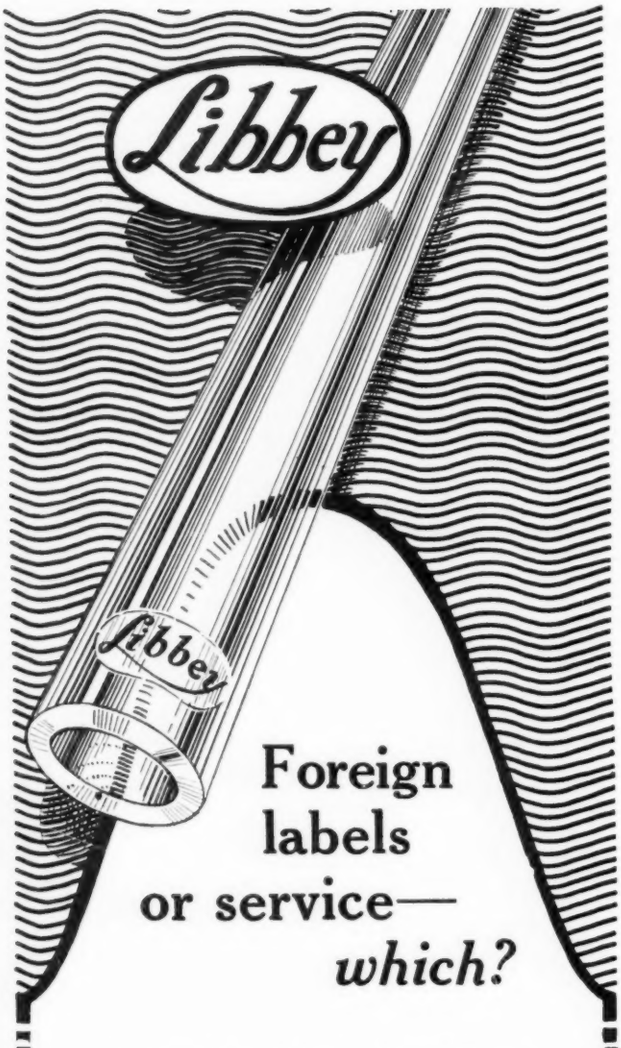

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For Stationary, Locomotive and Marine Boilers

For over twenty years, the Company's mills have been making high grade tubes for Babcock & Wilcox boilers. The same careful selection of raw materials, close supervision of manufacture and rigid final inspection are followed whether the tubes are made for Babcock & Wilcox boilers or for any other purpose.

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In boilers of any type the test of clean tubes is the **DEAN**
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Feed Water Heaters and Purifiers

will heat the feed water from 40° F. to from 200 to 212° F. and remove all impurities.

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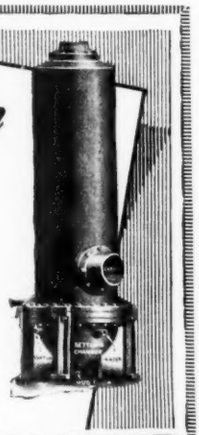
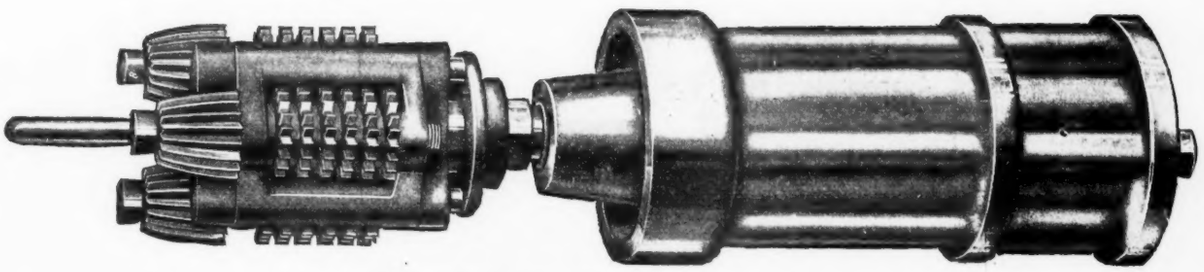


ROTO TUBE CLEANERS



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For Tubes of All Types

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Clean Tubes—Mean Lower Coal Bills

You cannot maintain maximum heat transmission in your boilers if the tubes are coated with soot. Keep them clean and save coal by using the

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Blows out every grain of soot by dry air, using just enough steam to get a continnous strong blast. This cleaner is more efficient than the use of a scraper and brush. It is light and easily handled. Sent on trial.

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Williams Automatic Boiler Room Appliances used everywhere

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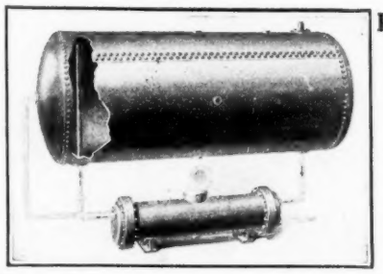
ROSS *"Better Than Specified"*

Improved **Storage Type Heater with Positive Return Circulation**



A combination of an instantaneous heater and a storage tank that insures a continuous supply of HOT WATER at a low cost. Write for bulletin 129.

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They will save from 10 to 15 per cent on your coal bill by recovering a large part of the heat now being wasted up your stack.

Millions of boiler horsepower to prove this saving. Get all the facts.

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Iron and Oil Removal Apparatus—Filtration Equipment—Water Conditioning Apparatus of every description

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Hot—Cold—Intermittent—Zeolite
Complete Engineering Service
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"The Pioneer Boiler Treatment"
Positively removes and prevents scale, stops leaks, pitting and corrosion
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Recovers 70% stack heat, raises CO_2, improves combustion—*Bulletin on request.*

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WATER PURIFICATION SYSTEMS SOFTENING & FILTRATION FOR BOILER FEED AND ALL INDUSTRIAL USES
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Upward Flow Zeolite Softeners — Pressure Sand Filters
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PROTECT YOUR CRUSHER
Keep Out Tramp Iron with a
High Duty Magnetic Pulley
Valuable Booklet sent free on request.
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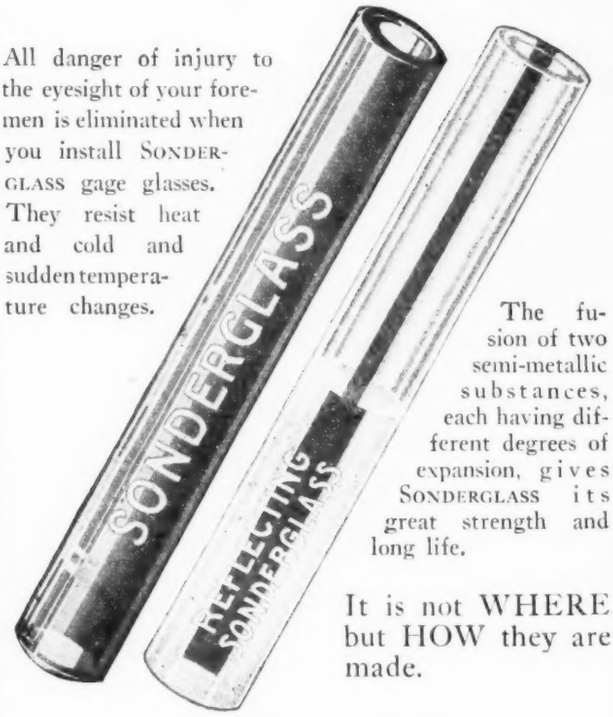
All danger of injury to the eyesight of your foremen is eliminated when you install SONDERGLASS gage glasses. They resist heat and cold and sudden temperature changes.



The fusion of two semi-metallic substances, each having different degrees of expansion, gives SONDERGLASS its great strength and long life.

It is not WHERE but HOW they are made.

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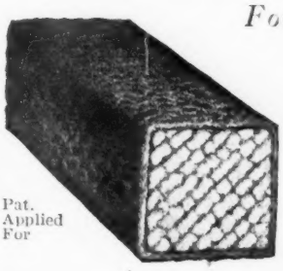

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1. All Asbestos
   No rubber back to burn out.
2. Graphite Between the Plys
   Allowing slippage and preventing hardening.
3. Its Diagonal Construction Means Greater COMPRESSIBILITY
   This is the purpose of a Steam Packing.
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   The stuffing box does the rest after packing is adjusted.

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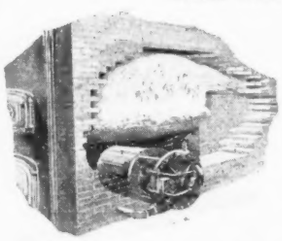
Plenty of draft in bad weather
with the **Wing Turbine Blower**



The Original - The Standard
1905 since 1905

Many chimneys give just enough draft, with clear dry weather; but let the barometer vary ever so little, and it becomes a tug and a pull to make it go. The Wing blower corrects this condition; plenty of draft, and to spare, at all times—The cost is little, installation simple, and no trouble to maintain.

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RADIAL BRICK RUST CONCRETE
BOILER SETTINGS
COMPLETE POWER PLANTS

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THERMIX AIR PREHEATER
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give lasting service under severe operating conditions. Designed and built by men with long experience.

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SUCCESSOR TO FILES STOKER
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GIBBY STOKERS will burn all grades of fuel. High efficiency — low maintenance — less labor.

Write for name of plant using your kind of fuel.

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Marion Hand Fired Stokers

Non-interlocking teeth of special design present very small openings which will not permit the loss of live coals or unburned fuel. Nothing but fine ash can drop through into the ash pit.

Movement of the fuel bed is positive and continuous from step to step over the grate toward the dumping plate. Every bit of energy from the coal is extracted by this economical clean method of firing.

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MARION POWER PLANT EQUIPMENT

DETROIT UNDERFEED STOKERS

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"The world's simplest Stoker"
A ¼-hp. Motor Drives It. Hook it to a lamp socket.
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Hand Stoker (HeavyDuty)
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A Stoker for Every Boiler

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LACLEDE CHAIN GRATE STOKER
The stoker for the higher volatile coals, dominant in this field today.
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The FORCED DRAFT travelling grate stoker with 7 improved features you should know about. Send for Bulletin 11 to Rosedale Foundry & Machine Co., Columbus and Preble Ave.'s Pittsburgh, Pa.

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A complete system—for machine regulation of any number of boilers from one central point. Many prominent installations.
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Leaders in Modern Combustion Control

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With Dampered AIR CONTROL

Forced or Natural Draft
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OIL BURNERS and OIL BURNING EQUIPMENT
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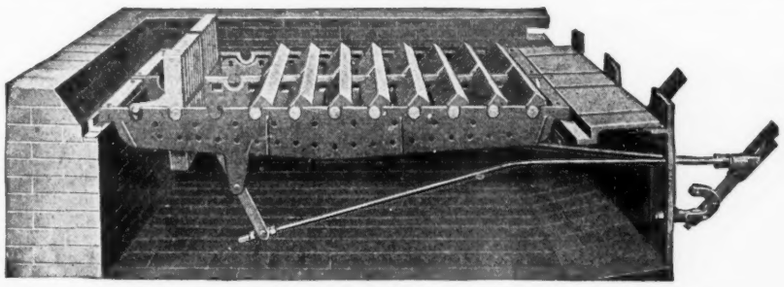
Rocking and Dumping Grates

KELLY GRATES GOSHEN IND.



No, Mr. Brown, your steam gauge is not out of order!

True, the gauge may fluctuate to an alarming extent, but that does not mean that it is not working properly. Take a look at your grates Mr. Brown. Do they necessiate cleaning the fires through open doors? Every time you open the fire-door to use a slash bar you cool the entire furnace.

With a Kelly Rocking and Dumping Grate the ashes and clinkers may be removed without opening the doors. Moreover, on a Kelly no unburned coal can get into the pit and the air spaces are always open. All these features make for steady steam pressure and economy in fuel consumption.

Write now for your copy of our new Catalog.

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OIL BURNING EQUIPMENT
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FOR ALL Purposes Kinds of gas Pressures
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Ash Gates Ash Storage Bunkers Standardized Sluicing Systems "Catenary Curve" Cast Iron Coal Bunkers Ash "Quenchers" Air Cooled Bottoms for Powdered Fuel Furnaces Sectional Cast Iron Ash Hoppers

For Economizing on Fuel Bills

There is no better way than to equip all boilers now, with

CYCLONE

Shaking and Dumping Grates

Made up with one-piece grate bars, having tapered air spaces. These admit more air at a higher velocity than is possible with ordinary grate designs. Better fuel bed penetration results and more coal is burned per square foot per hour.

You can save at least 10 per cent in fuel with Cyclone Grates if you now operate stationary grates.

May we show you why? Write for Bulletin.

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Air for your Stokers—at Less Expense

Whether for forced or induced draft—every operating requirement can be met economically by installing properly selected

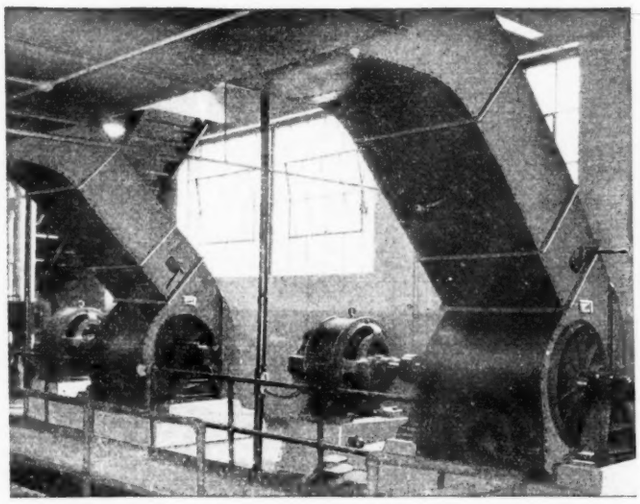
"Buffalo" Conoidal Stoker Fans

All have a rising pressure characteristic, which modulates the static pressure in proportion to the thickness of the fuel bed and adapts the stokers for parallel operation in delivering air into a common duct.

When equipped with inlet guards a high operating efficiency can be maintained up to moderate overratings with a gradual increase in driving power. Where extreme overloads are to be carried the inlet guards are omitted.

Built for direct connection to either constant or variable speed electric motors and to steam turbines. Where slower speeds are desired for induced draft a duplex type is furnished.

Our engineering department is at your service to assist in the selection of the right fans for your stokers or pulverized fuel fired furnaces. ***Write for Catalog No. 730.***



Buffalo Turbo Conoidal Fans with inlet guards delivering forced draft at the Park and Davis Co., Detroit, Mich.

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"Buffalo" Mechanical Draft Apparatus

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By Burning Low Priced Fuel

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At the same time you can increase your boiler rating as the Coppus Blower helps your chimney—its capacity is increased by at least 100%.

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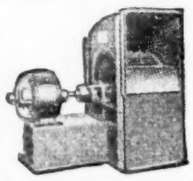
Incorporated 1886
ASHLAND, KENTUCKY
Manufacturers Of Sized Brick



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For Mechanical Draft, Heating and Ventilating, Exhausting and Drying. Have Clarage Engineers co-operate with you.

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The Neemes Grate combines extreme strength to meet hard usage with qualities that enable it to meet to a surprising degree the high temperatures occasionally encountered in boiler furnace operation. They will not warp or burn and the frame work is generously proportioned and correctly designed. The result is long life and reliable service.

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Wide flexibility. Ideal flame control. A 100% load range without changing burner tip. Increased output of any type of boiler. Write for Bulletin "M."

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Shipped in wet form in barrels weighing 100, 200, 300, 500, 700 lbs.

It can be used for laying up brick work, patching furnace settings or for building solid monolithic walls.

By veneering your walls with RED FLAME Cement, you will obtain a coating that is almost impenetrable. It will prevent gas seepage at the joints and will protect the surface of the fire brick from injury by clinkers.

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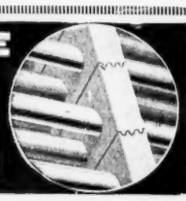

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Write for your copy of "Refractories and Furnace Design." It tells how to get longer furnace life—how to cut heat loss—how to decrease installation cost

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BETSON'S TRADE MARK PLASTIC FIRE BRICK
for permanent one-piece boiler furnace linings and baffles—No bricks to fall out—Ready *(in yellow topped barrels)* for any one to do the job, from warehouses in principal cities. Saves waiting for repairs. *There is only one "PLASTIC FIRE BRICK"*
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FACTORIES—ROME, N.Y. and ST. LOUIS, MO. — SEND FOR CATALOGUE

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FROM COAST TO COAST
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Keep your Boiler Furnace Linings in Continuous Repair

Avoid the danger of collapse and shutdown. Save the cost of installing new linings. You can do both, by re-surfacing the entire lining with a mixture of crushed old fire brick, fire clay and water by means of the "CEMENT-GUN." A one-man, compressed air-operated machine that packs the material into place, fills all holes and crevices and produces a lasting, vitreous coating that does not crack, crumble or peel under any furnace condition.

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A highly efficient machine with a wide range of usefulness in the power plant. It will build up arches, bridge walls and baffles, repair every part of the furnace lining, line coal bunkers, ash pits and stacks and apply protective coating to exposed structural steel.

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The "CEMENT-GUN" is not a restricted article and may be purchased and used by anyone. However, we also have a Contract Department prepared to give you bids on lining your coal bunkers, ash pits, breechings, stackr, etc., or for the repair of concrete and masonry structures, fire-proofing and protecting structural steel, building construction and other similar work.

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I would also be interested in receiving quotations for lining coal bunkers, ash pits, etc.

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This booklet contains a number of suggestions that will help you get greater life from your fire brick. Ask for a copy for each man in your organization who is interested in better brickwork.

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For Preserving Coal Bunkers

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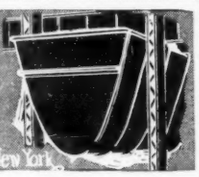

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Grinding Drying Thickening Clarifying Spraying

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R.O.M. COAL CRUSHED TO STOKER SIZE *Less than 2¢ per ton*

AMERICAN RING CRUSHER

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CHAMPION STEAM COAL

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THE LARGEST COMMERCIAL PRODUCERS OF — BITUMINOUS COAL —

FULLER-LEHIGH
Pulverized Coal Equipment

THIS new high pressure station of the Columbia Power Company, Cincinnati, Ohio, operates with complete FULLER-LEHIGH PULVERIZED COAL EQUIPMENT, WHICH PREPARES, TRANSPORTS AND BURNS the coal under eight Babcock and Wilcox Boilers. Each boiler has a heating surface of 15,000 sq. ft. A maximum of 20,000 lbs. of coal per hour is burned by the nine vertical and six horizontal burners installed in the furnace. Boiler pressure is 600 lbs. with 750 deg. F. total steam temperature.

These Leading Power Plants also selected

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Columbia Power Station
Dedicated to Public Service—
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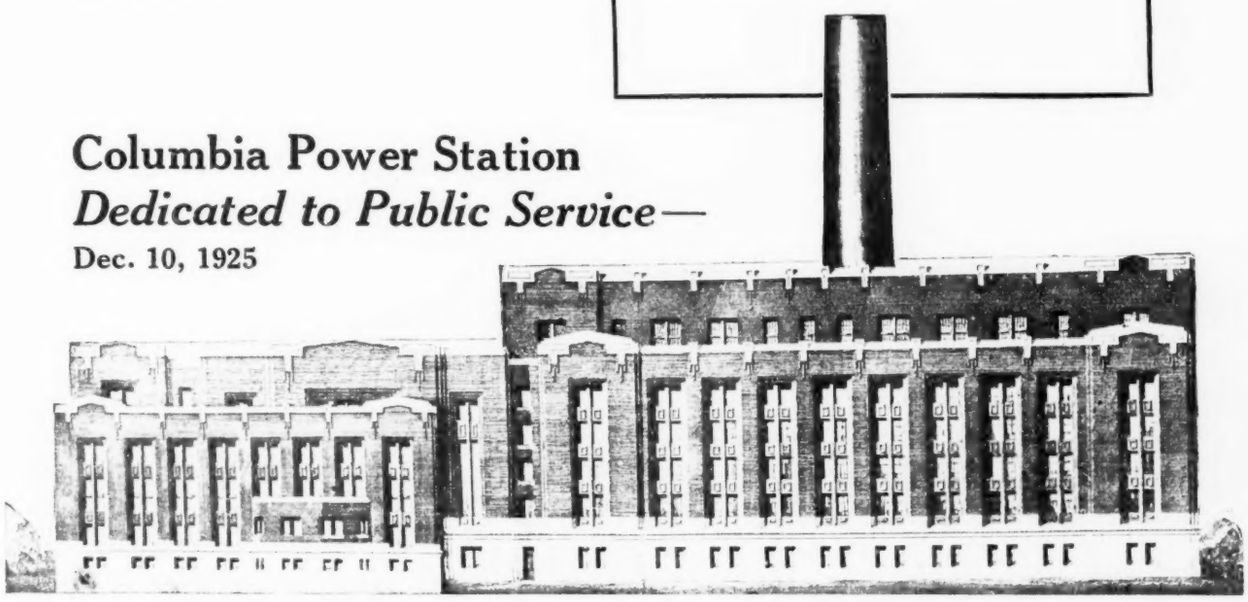

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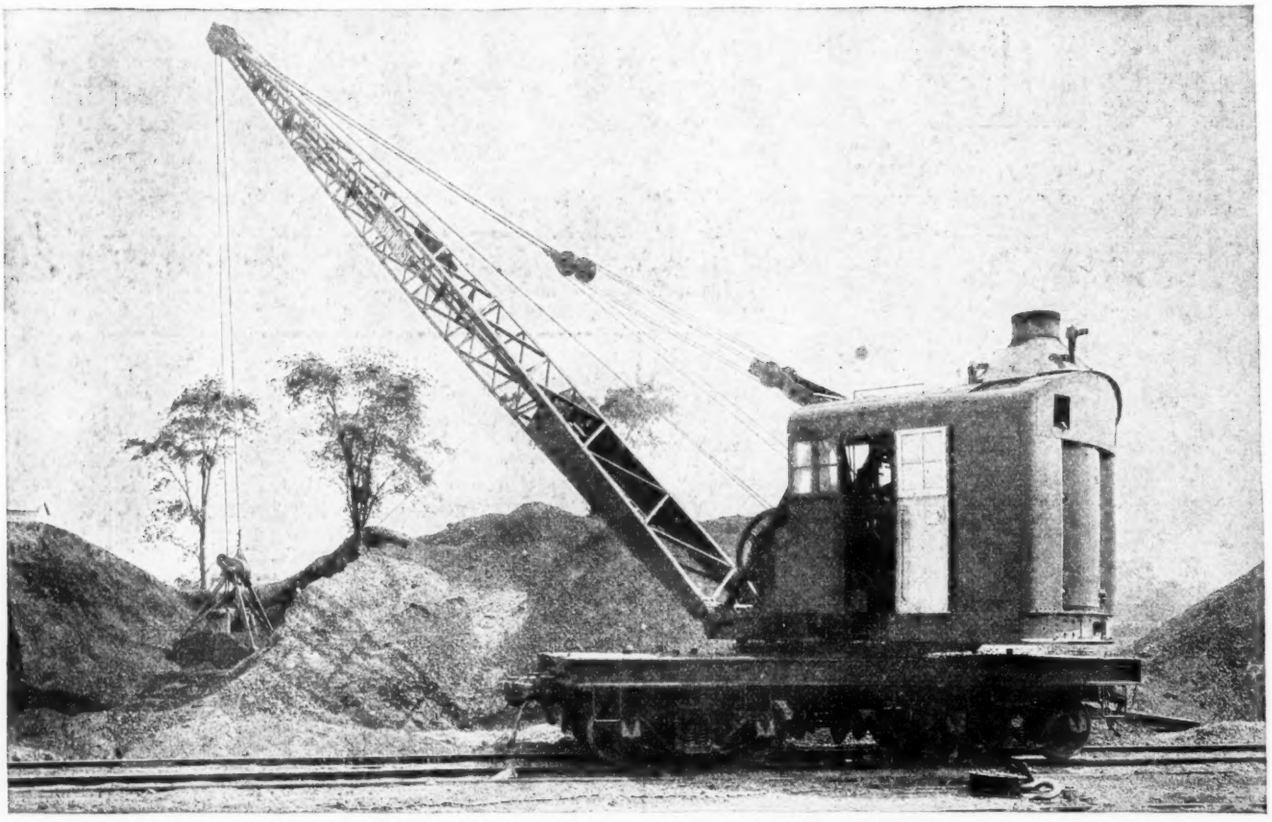

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Setting New Performance Standards

All over the country and on many kinds of work the improved Brownhoist cranes are establishing new low cost handling records for their owners.

You know the great time and money saving possibilities of a locomotive crane—investigate now the even greater output and better performance of these newest Brownhoists. Then we believe, you'll agree that it will pay you well to have one of these better cranes on your work.

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Branch Offices: New York, Chicago, Pittsburgh, San Francisco, New Orleans, London, Eng.

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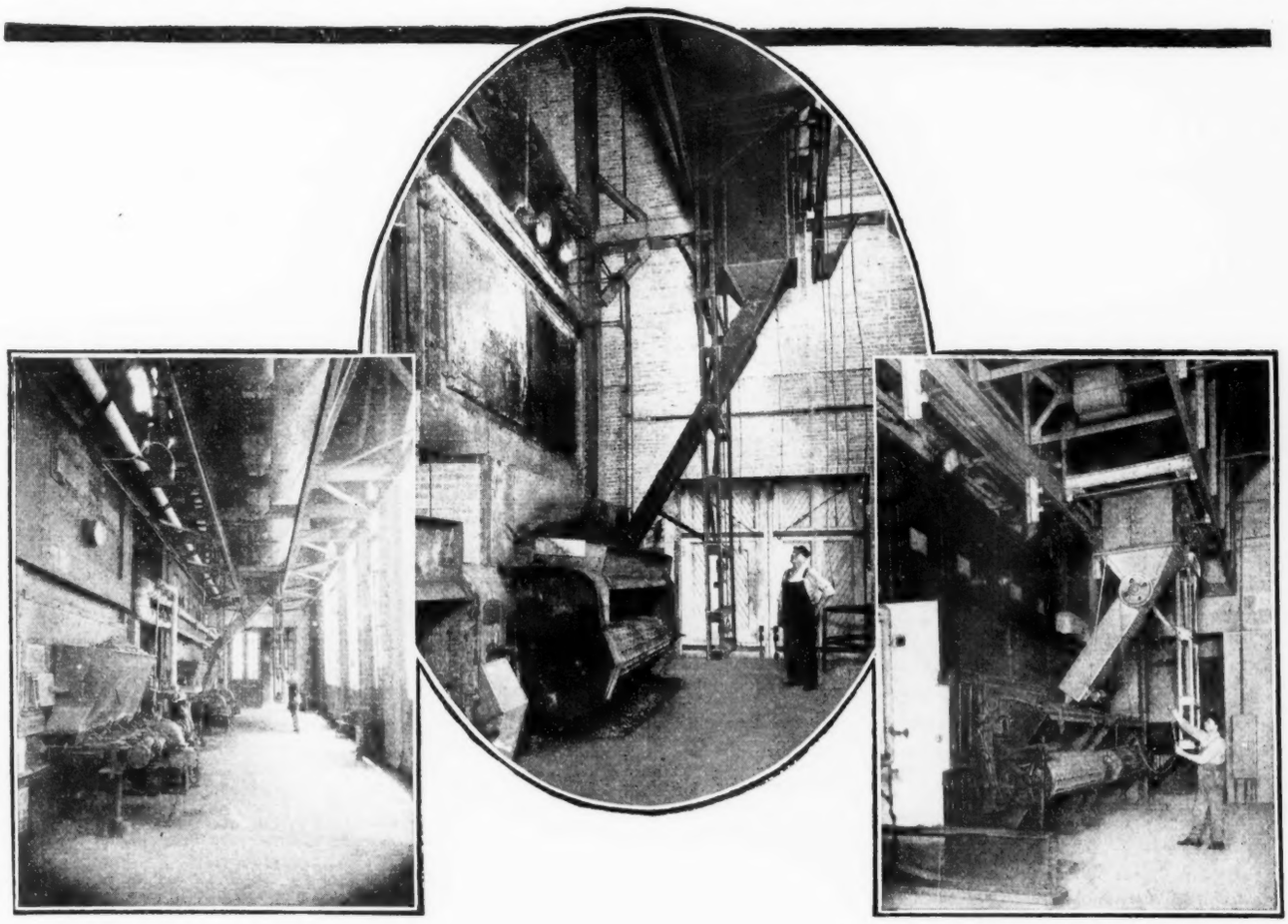
GOOD MATERIAL HANDLING MACHINERY

WEBSTER



Save Fuel and Labor with a Webster Weigh Larry

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Webster coal and ashes handling machinery in the boiler room saves both fuel and labor and makes a clean, orderly boiler plant, easy to maintain at all times.

With a Webster Traveling Weigh Larry accurate fuel consumption records can be constantly kept on each boiler. These weigh larries are both a distributing and weighing device.

Webster Weigh Larries are built to suit power plant conditions and in sizes from 500 to 5,000 pounds capacity or larger, and in hand or motor operated types.

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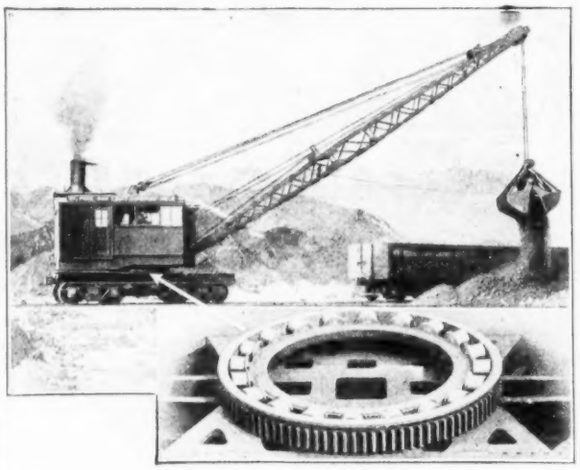

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Contrast the *common* practice of mounting the revolving deck of locomotive cranes on six little wheels running on an open track with the true roller bearing on which the machinery deck of "AMERICAN" Locomotive Cranes revolves. The weight of the deck and the load being handled is carried on 20 conical steel rollers. No load falls on the roller axles. The only purpose of the axles is to keep the rollers evenly spaced around the circle. The Roller Path System is fully enclosed, reducing wear and friction to the vanishing point.

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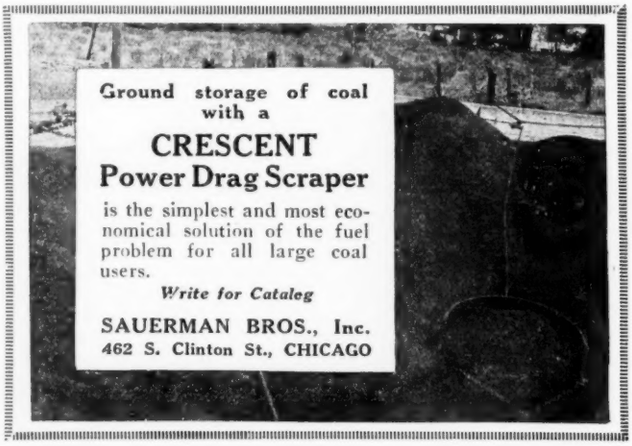

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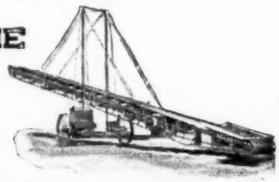

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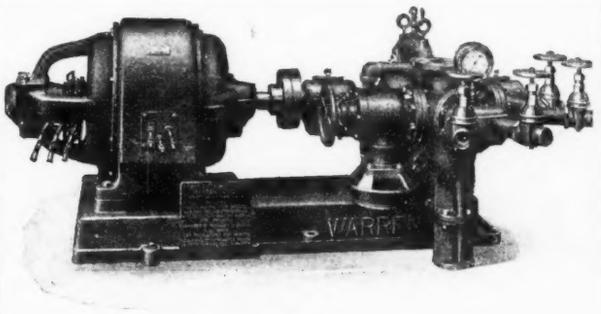

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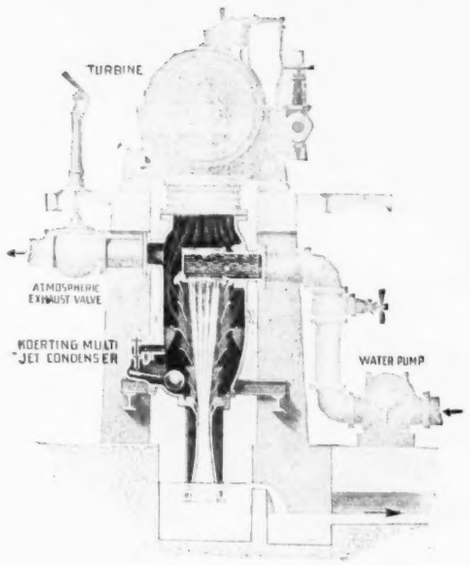

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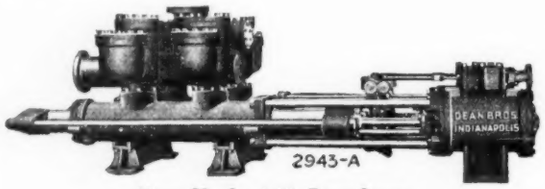

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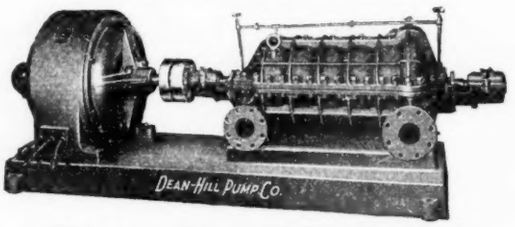

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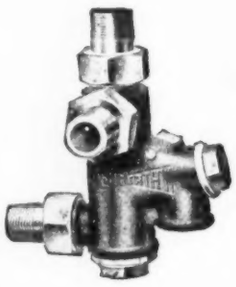

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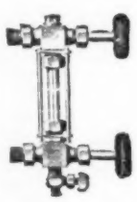

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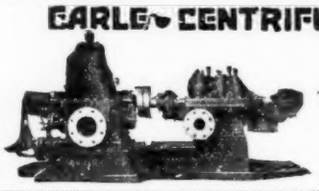

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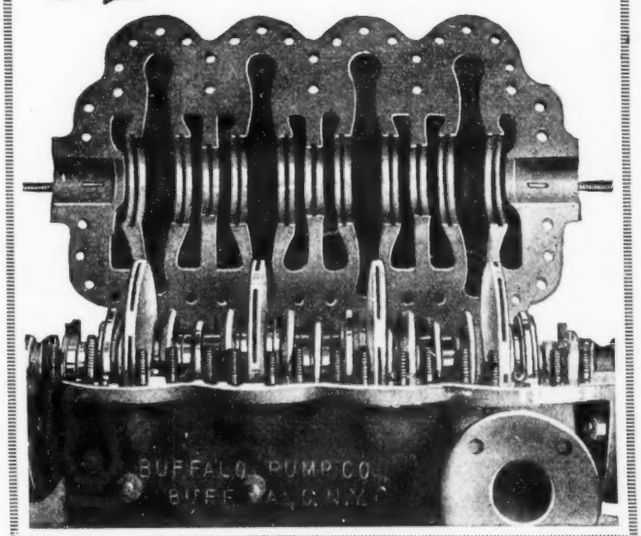

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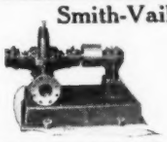

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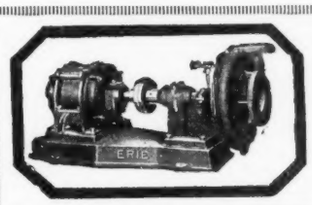

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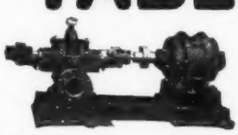

Fig. 510 illustrates Taber SL Double Suction Centrifugal Pump
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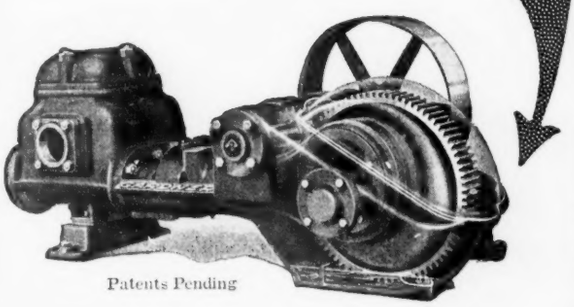

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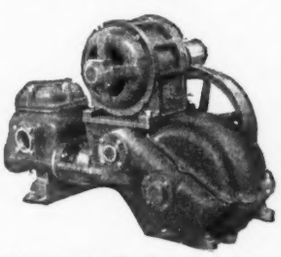

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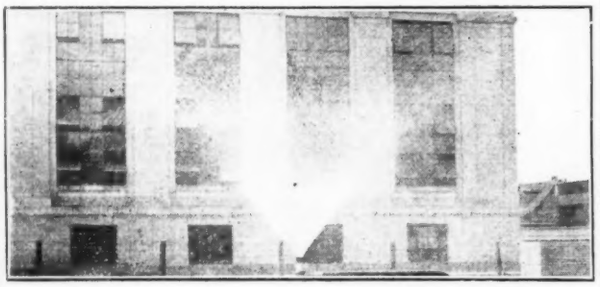

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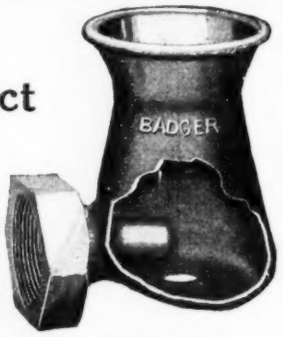

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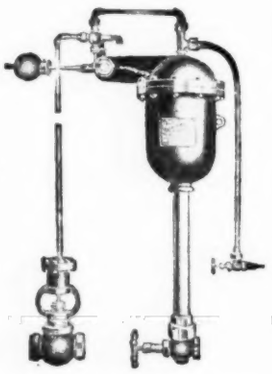

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Three Valve Pumping

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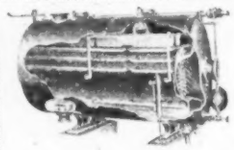

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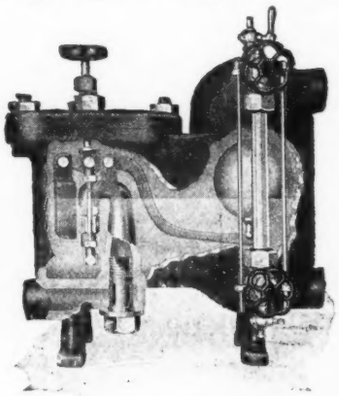

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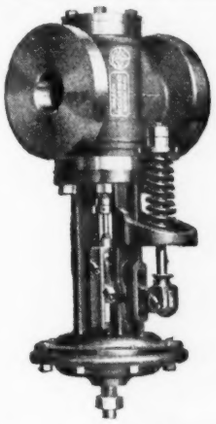

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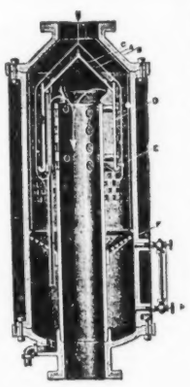

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All sizes and types are available.

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The inverted submerged principle gives: Greater capacity than any trap of equal size. Self-scrubbing. Cannot pass steam, action quick and positive. Non air-binding. Small size. Low cost.

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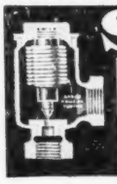

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NASON MANUFACTURING CO. 71-FULTON ST. NEW YORK CITY
Steam Specialty Specialists Since 1841

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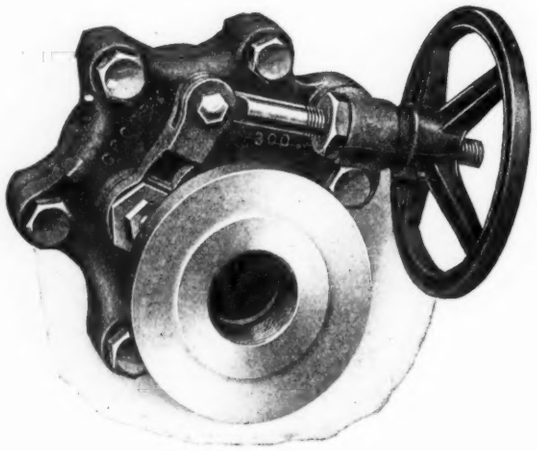

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FULLWAY VALVES

—will give drop-tight service that saves many little leaks throughout the plant. And a saving in power shows in increased profits.

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FOR EVERY POWER PLANT SERVICE

Gate, globe, angle and check valve patterns; all bronze, iron body—bronze mounted, and all iron; for screwed or flanged connections, and in a wide range of sizes for low, medium, high and extra high pressures. Also complete lines of standard cast iron flanged and malleable iron screwed pipe fittings. Send for catalog.

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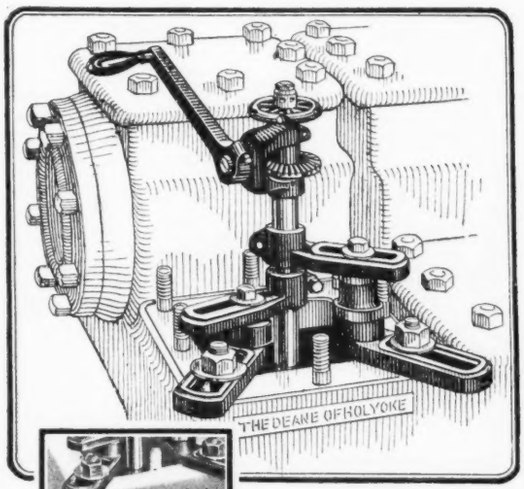

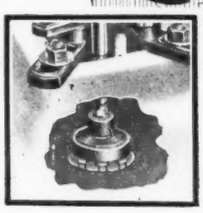

The Best Medicine for Sick Pumps

Just because a pump has lost its capacity or is wasting more power than it is turning into useful work is no sign that it is worn out or that it requires expensive part replacements.

A simple, inexpensive Dexter Pump Valve Reseating Outfit will restore it to normal in a few moments. And it will keep every reciprocating pump in your plant running at top-notch efficiency. Most likely it will pay for itself the first time it's used.

Ask us for Catalog 23 containing complete information.

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CANADIAN AGENCY:
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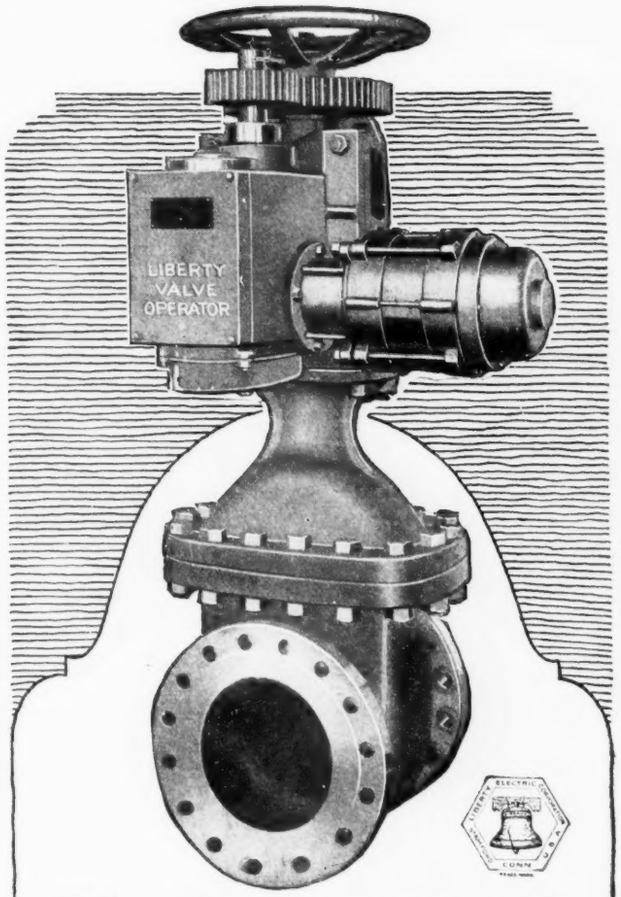
DEXTER VALVE RESEATING MACHINES



The Safety Clutch

makes overtravel impossible

No danger of jamming the valve stem in opening or closing. No danger of breakage in case of obstruction.

The multiple disk safety clutch of the

LIBERTY VALVE OPERATOR

slips the instant that the stem torque exceeds the predetermined safe limit. An invaluable feature that saves the valve in any emergency.

Accurate control of the valve travel—to within a few thousandths of an inch is made possible by the improved limit switch equipped with non-arcing, quick break phosphor bronze contacts.

The powerful magnetic clutch which drives the valve stem thru the disk safety clutch, is energized simultaneously with the motor but does not take hold until the motor has gained full speed.

Adapted to any standard gate or globe valve 6 in. and over. Local or remote switch stations or central control switchboard may be furnished to obtain any desired control.

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Liberty Electric Corp.

Stamford, Conn.

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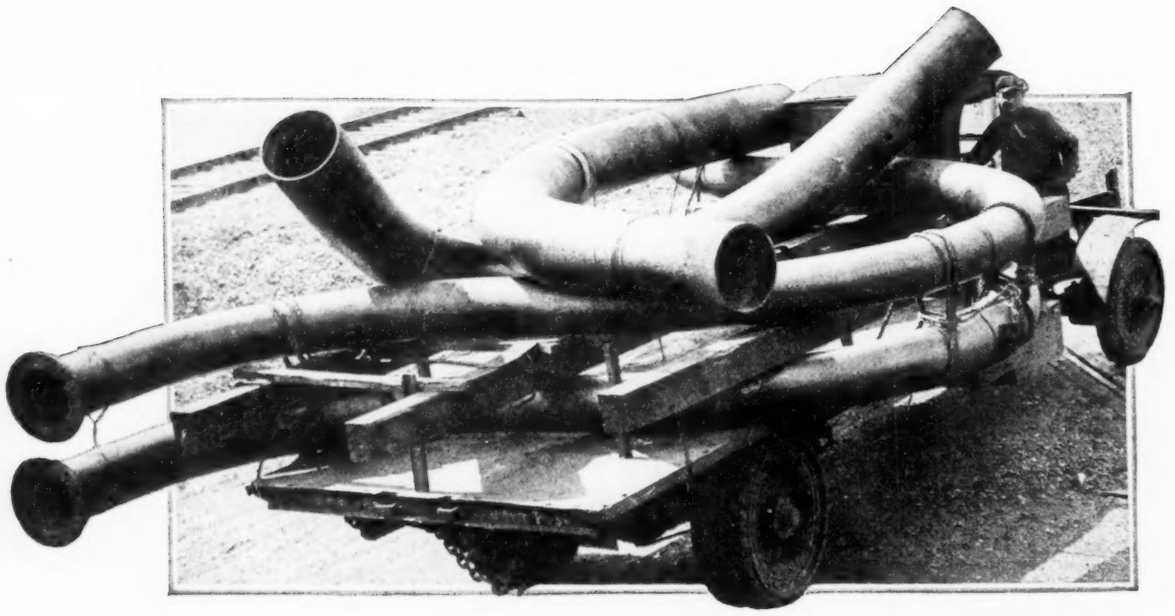

Regardless of shape, size, temperature or pressure—put it up to Kellogg

It's a "pipe" for us to meet any requirements you may specify. Our engineers are in close touch with the leading utility executives, mechanical engineers and consulting engineers and are constantly meeting new conditions and needs by delivering whatever is required.

Above for instance are shown: 12 in. double offset expansion U-bends made from one piece approximately 40 ft. long and 18 in. square bends. A 20 in. steam header 55 ft. long is another typical piece of work turned out in the Kellogg plant—the largest in the world devoted to strictly high pressure piping needs.

Whatever your piping requirements, Kellogg engineers will give you the solution. The first step is to get the Kellogg book on High Pressure and High Temperature Piping. Write for your copy today.

Partial list of recent purchasers of headers or piping

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Kearney, Public Service Prod. Co.
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Acme Power, Toledo Edison
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M. W. KELLOGG COMPANY
140 Cedar Street, New York City, N. Y.

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KELLOGG FORGE WELDED PIPE
FORGE WELDED CONTAINERS
POWER PLANT PIPING

ALL KELLOGG PIPING PRODUCTS ARE INSURABLE

the *Spiral Stripe*
on Byers Pipe
protects you against
mistakes and substitution

Fighting Rust in Industrial Plants

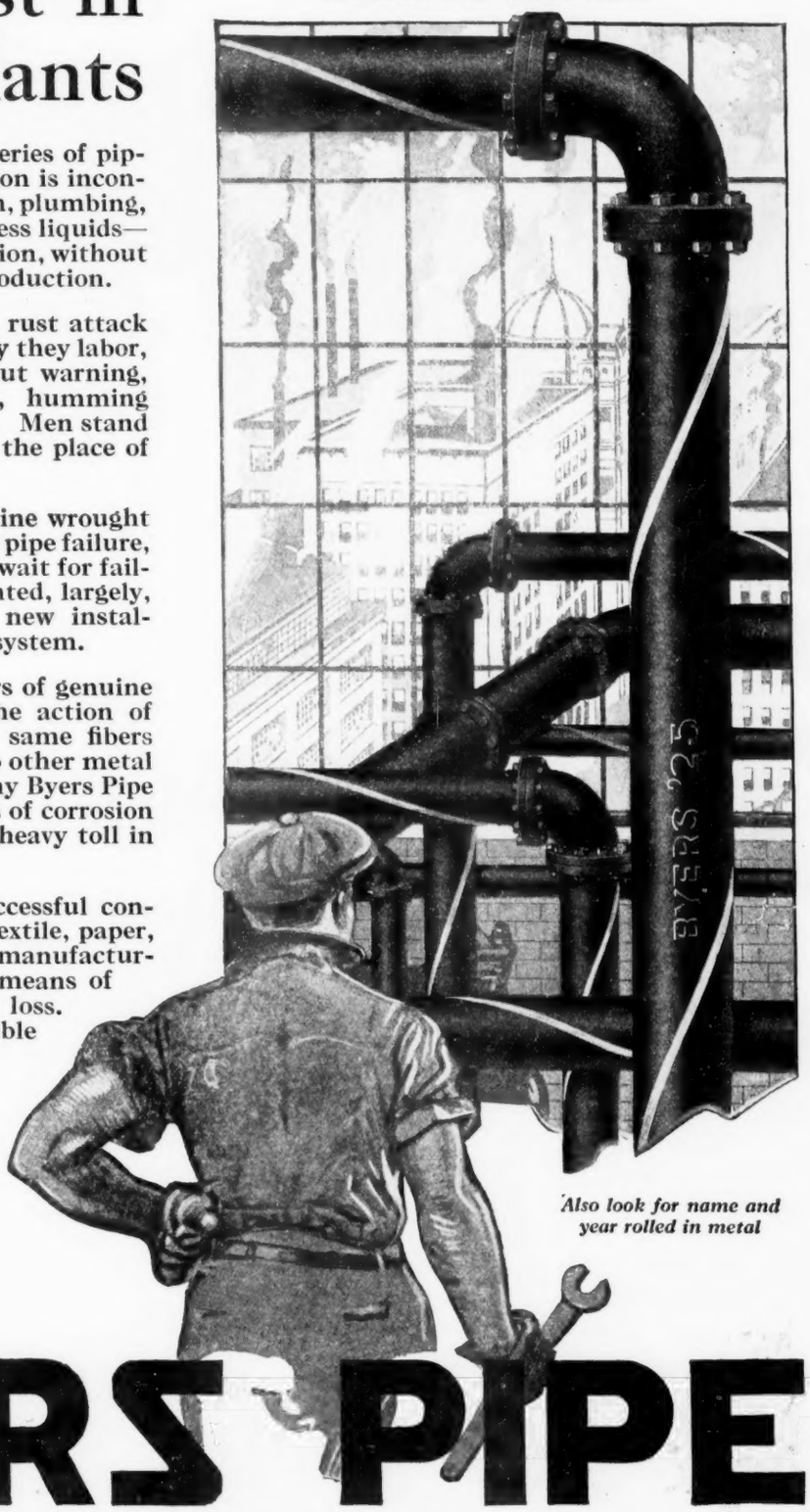
WITHOUT sound arteries—arteries of piping—industrial plant operation is inconceivable. Water supply, steam, plumbing, heating, compressed air, gases, process liquids—miles upon miles of pipe must function, without interruption, to insure profitable production.

But day and night, the germs of rust attack these arteries from within. Stealthily they labor, out of sight, out of reach. Without warning, they break through. Machinery, humming evenly a moment ago, is silent now. Men stand idle. Waste, disruption, loss, take the place of production.

For replacement, no doubt, genuine wrought iron will be used. After a disastrous pipe failure, you'll make sure of that. But why wait for failures to occur? They may be prevented, largely, by specifying Byers Pipe for every new installation or every extension of an old system.

The slag that surrounds the fibers of genuine wrought iron, protects it from the action of corrosive liquids and gases. The same fibers reduce the tendency to fatigue. No other metal has a similar structure. That is why Byers Pipe is so largely immune to the attacks of corrosion and crystallization that take such heavy toll in plants where cheaper pipe is used.

Many of the largest and most successful concerns—the giant rubber, cement, textile, paper, meat packing, food, and chemical manufacturing works—specify Byers Pipe as a means of preventing failures and attendant loss. Their experience might be valuable to you. Pertinent literature will be mailed on request.



Also look for name and year rolled in metal

A. M. BYERS COMPANY
Established 1864 PITTSBURGH, PA.

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BYERS PIPE

GENUINE WROUGHT IRON

THE NEW "TOLEDO" CATALOG YOUR COPY IS READY FOR YOU

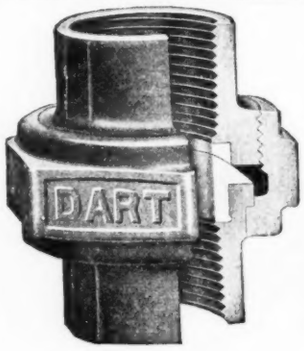
You should have a copy of this new catalog. It shows the finest and most complete line of pipe tools on the market.

You will find equipment shown therein that will reduce time and labor on your piping jobs.

Just send us your name and address and we will send you a copy.

THE TOLEDO PIPE THREADING MACHINE CO. Toledo, Ohio

NEW YORK OFFICE, 50 Church St.



Bronze to bronze keeps them tight—

DART UNIONS

have bronze seats swedged into a groove and ground to ball and socket joint. These seats cannot work loose, cannot corrode, cannot stick.

The plant equipped with Dart Unions has cut out its pipe line troubles. We are so sure of this that we offer to replace any defective Dart Union with two perfect Dart Unions, without charge.

Made in a complete line for every need. Try them out on the trouble spots.

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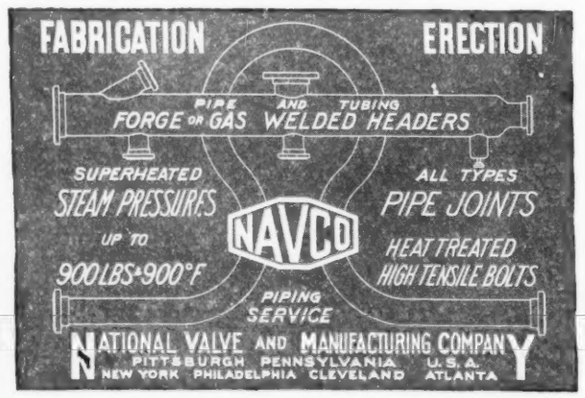
Dart Union Co., Ltd.
Toronto, Canada



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Forged from solid steel billets. In stock, drilled, threaded, finished complete for immediate shipment, to fit all sizes standard wrought pipe. Stock sizes 150, 250, 400 and 600-pound standards.

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AN ABSOLUTELY TIGHT DURABLE PIPE

Fully 50% stronger than Straight Riveted Pipe of equal thickness. Light weight and simplicity of bolted connections results in low handling and installation expense. Extensively used in Power Plants for Atmospheric Exhaust, Cooling Pond and Forced Draft. Particularly adaptable for Suction and Discharge Water Lines, Vacuum Lines, Exhaust Steam Lines to Dryers, etc., and Large Low Pressure Air Lines.

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Ready to Erect—Including

PIPE BENDS—FLANGED PIPE—WELDED NOZZLE HEADERS VALVES—FITTINGS—SPECIALTIES

For Any Pressure or Service

MIDWEST PIPING AND SUPPLY CO.

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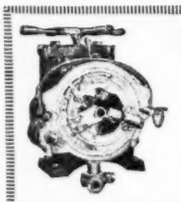

Save Money in Threading Pipe

One man can cut and thread pipe in all sizes to 16 in. on a

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Requires so little power, that any size may be operated by hand, when necessary. Larger sizes furnished with motor enclosed in base. Easily portable and may be taken right up to the pipe or head to be threaded. Saves labor in carting heavy pipe. *Write.*

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OF EVERY DESCRIPTION.

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We invite inquiries on piping fabrication, bending, flanging, welding or engineering advice on individual problems

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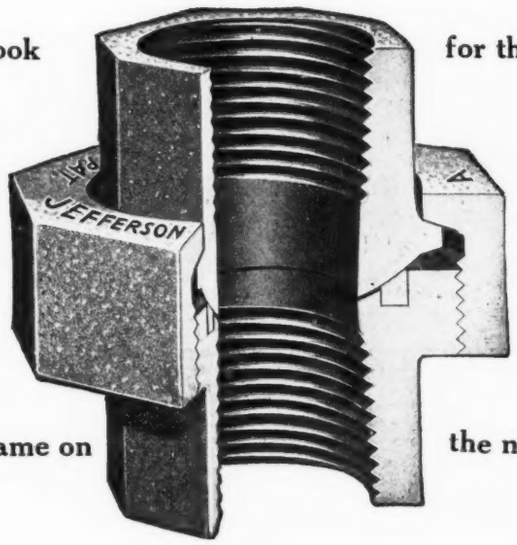


name on the nut

"Jeffersonized" means Leak Proofed

Leaks in pipe lines are needless—costly and an indication of faulty buying. A pipe line system is as good as its unions.

Jefferson Unions

are built with the possibilities of leakage left out. They are tight and remain so throughout their life because their design is such that the weakest points in the average union are Jefferson strong points.

The services of a Jefferson engineer are yours without obligation, and—for a parting word—Did you ever profit through leaking joints?

The Jefferson Union Co.
Lexington, Mass.

TURBINAIR

Save Man Power
in Lifting and Hauling

You can save man power and time on the little lifting and hauling jobs, by doing them with

SULLIVAN TURBINAIR HOISTS

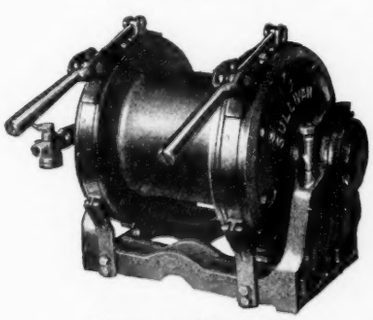
In one plant, 4 of these hoists are used. One hoists patterns and lumber to an upper floor, one hauls freight cars in and out of the raw materials yard, one pulls full sand hoppers out on the foundry floor and pulls empties back under the mixer, and one hauls castings on a truck from one part of the foundry to another.

All small jobs, but performed many times a day.

And outdoor uses are legion.

"Turbinair" and Electric Portable Hoists will haul a 100,000 lb. car on level track, or lift 2,000 lbs. vertically on single line. Single or two drum models 350 ft. ⅜ inch wire rope.

Ask for Bulletin 776-F.



Sullivan Turbinair Hoist

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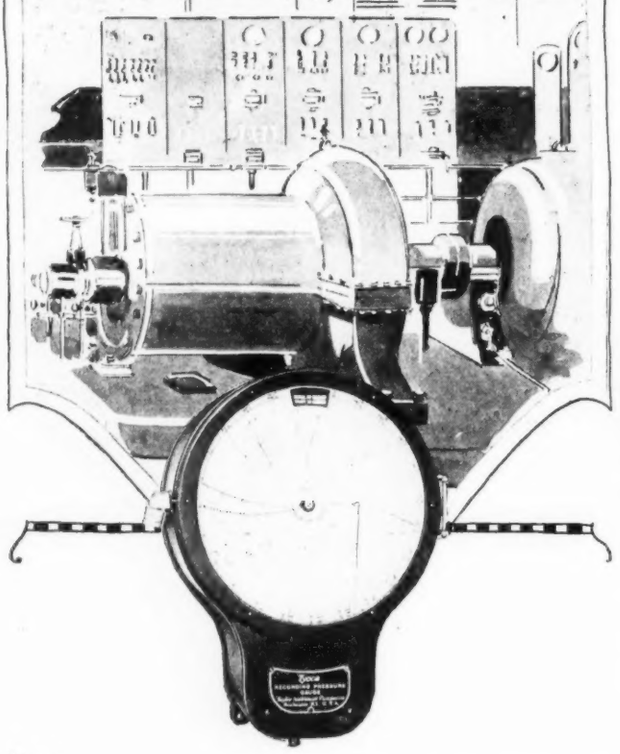
Tycos

Recording Gages for Pressure and Vacuum



Let

Tycos

Gages help you maintain the right pressures

Plant operators are only human. They will read an indicating gage and unintentionally forget the reading. Apparently no great harm is done, because there is no evidence of anything wrong when the pressure is restored. Nevertheless you shoulder the loss in decreased production or in extra fuel.

With *Tycos* Recording Pressure and Vacuum Gages on the job, the picture is a different one. The EVIDENCE IS THERE—indelibly written on 24 hour charts.

Inefficient pressures on steam, water, oil, gas or air are shown together with the time they appeared and how long they were allowed to continue. A continuous check on pressures is available.

Tycos Pressure Gages are reliable. The simple mechanism transmits the movement of a spring or diaphragm to the pen arm by a single link. A strong and well finished metal case gives full protection and keeps out the dust. Like in other *Tycos* Instruments, the adjustment of the pen arm is sealed and cannot be disturbed by any unauthorized person.

Tycos Recording Pressure Gages have a range up to 5,000 lb.

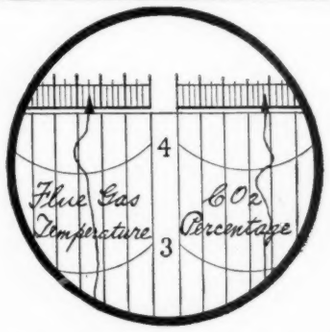
Write for catalog on Tycos Instruments for the Power Plant

Taylor Instrument Companies

Rochester, N. Y.

Canadian Plant: 110 Church St., Toronto 493

THE BROWN INSTRUMENT CO., PHILADELPHIA, PA.



How much more would you save?

Engineers figure that you can, conservatively speaking, save 13% of your fuel by checking stack temperatures. How much more can you save, if side by side—on one chart—you can compare continuous records of both CO_2 and your stack temperatures—and do this electrically?

Brown Electric CO_2 meters

Two valuable Booklets entitled "Measuring CO_2 Electrically," and "Approval Deserves Weight," will be sent to you upon request. Write for them.

Address—THE BROWN INSTRUMENT COMPANY, 4512 Wayne Avenue, Philadelphia, Pa.
or one of our District Offices in New York, Boston, Pittsburgh, Cleveland, Detroit, Chicago, Indianapolis, Birmingham, Houston, Tulsa, St. Louis, Denver, Salt Lake City, San Francisco, Los Angeles or Montreal.

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ELECTRIC MFG CO.

Standard or special switchboards and control apparatus.

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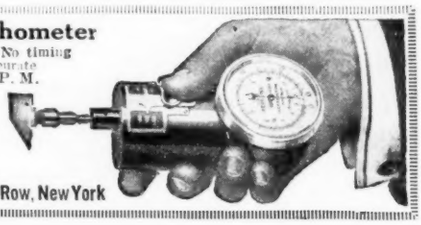
O-Z Hand Tachometer

Speeds at a glance. No timing "Dead Beat" Accurate
30—24,000 R. P. M.

Hand Tachograph

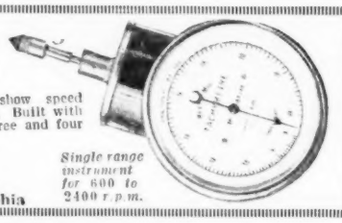
Draws graphic charts of speeds.

Circulars on request



O. Zernickow Co., 21 Park Row, New York

"Jagabi" Type C Hand Tachometers



accurately indicate speeds and show speed variations. Large dial easily read. Built with one range (as shown) also with three and four ranges up to 24,000 r.p.m.

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Indicating and Recording Gauges, Gauge Testers, Indicating and Recording Thermometers, Tachometers, Temperature and Pressure Controllers, Pop Safety and Water Relief Valves, Steam Traps, Engine Indicators, etc. *Write for Catalog N-32*

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Metallic Packing
Style 100
Used widely for low friction, non-abrasive results on centrifugal boiler feed pumps, engine rods under 450 ft. per min., Corliss valves and valve stems.
An engineering product of spirally wound endless ribbons of babbitt foil impregnated with flake graphite.
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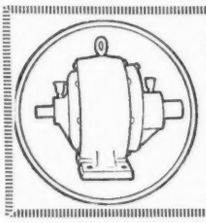

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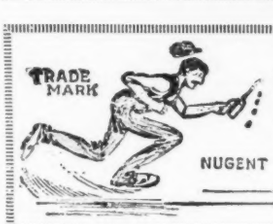

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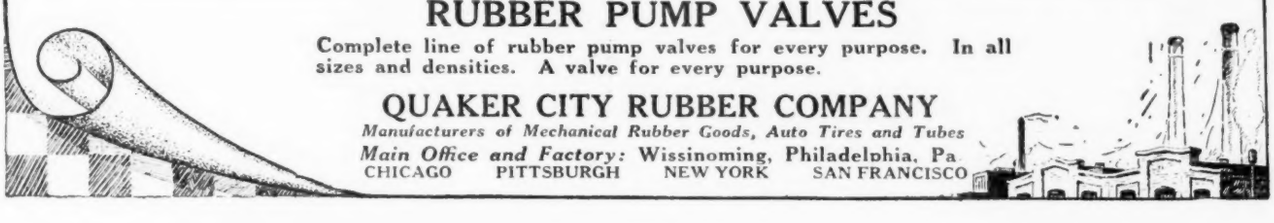

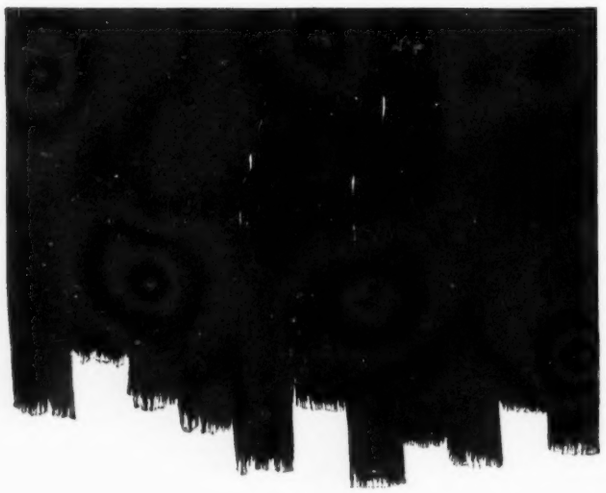

The invisible costs in a can of paint

WHEN you paint anything around the plant, you pile up two invisible costs, besides the easily seen cost of the paint itself. First, the cost of the temporary delays and possible shutdowns, and second, the cost of the painter's time, which is by far the biggest item of all.

There is a glossy black paint that hasn't got those costs mixed in it. That paint, Nitrose, stands extremes of heat and cold without cracking. It stands brine and sulphurous acid and hard wear. It outlasts ordinary paints by two or three times. And so it saves that big cost of repainting.

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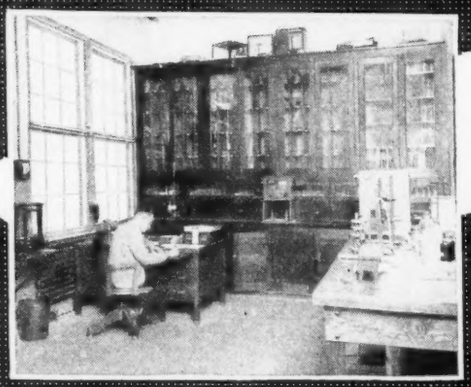
GARLOCK

RIGHT!



CORNER OF METALLURGY LABORATORY

By RIGHT, we mean
Garlock Metal Packings
are MECHANICALLY RIGHT

All metals used in the manufacture of Garlock Metal Packings are alloyed to our specification and have to stand rigid tests.

The Packing Rings are tested for specified hardness according to the service they have to render.

Every set of Packing shipped is inspected to determine if it is Mechanically Right as to fit, workmanship and micrometer measurements.

When Garlock Metal Packing Service is installed in your Plant you are receiving the last word in Metal Packing Craftmanship.

TESTING PACKING RINGS FOR HARDNESS

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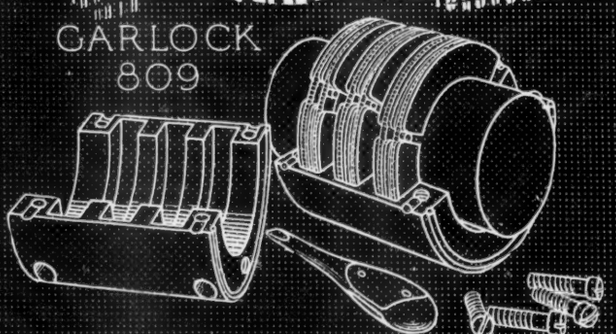

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Asbestos Rubber GARLOCK PACKINGS Metal Fibrous
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Sales Offices in all Principal Industrial Centers

Metal Packing Catalog AA-1925
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The Standard Packing of the World

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Complete oil and tar burning systems for Power Plants.
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Specialist in design and construction of Diesel Engine Power Plants exclusively; Diesel electric installations and auxiliaries complete. Buffalo, N. Y.

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Professional Directory Department
POWER
10th Ave., at 36th St., N. Y.

Gentlemen:

Please send us rates and other data for advertising in your PROFESSIONAL DIRECTORY.

Advertising —

as a builder of prestige and business standing is unquestioned. It is an immeasurable power in influencing new business and retaining good-will.

Professional Cards —

in this paper offer a highly appropriate type of publicity for the services of professional men in the Power Plant field.

Your Card —

should appear in this directory regularly. If it is not there now—

← CLIP AND MAIL THIS COUPON

SEARCHLIGHT SECTION

USED MACHINERY & NEW—BUSINESS OPPORTUNITIES

UNDISPLAYED—RATE PER WORD:

Positions Wanted, 4 cents a word, minimum 75 cents an insertion, payable in advance.

Positions Vacant and all other classifications, 8 cents a word, minimum charge $2.00.

Proposals, 40 cents a line an insertion.

INFORMATION:

Box Numbers in care of any of our offices count 10 words additional in undisplayed ads.

Discount of 10% if one payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 to 3 inches.....$5.00 an inch
4 to 7 inches..... 4.80 an inch
8 to 15 inches..... 4.60 an inch

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

Power

POSITIONS VACANT

Missouri

MECHANICAL engineer to take charge of engineering department of a company manufacturing water tube boilers. Mus come well qualified. P-12, Power, 7 So. Dearborn St., Chicago, Ill.

New York

WANTED—An advertising writer with an engineering background. One of the largest manufacturers of industrial equipment in the New Jersey d strict requires an assistant advertising manager who can put advertising originality into engineering copy. Write complete details of experience, etc., to P-15, Power, Tenth Ave. at 36th St., New York.

To Employers Who Advertise for Men:

The letters you receive in answer to your advertisements are submitted by each of the applicants with the hope of securing the position offered.

When there are many applicants it frequently happens that the only letters acknowledged are those of promising candidates. Others do not receive the slightest indication that their letters have even been received, much less given any consideration. These men often become discouraged, will not respond to future advertisements, and sometimes even question if they are bona fide.

We can guarantee that *Every Advertisement Printed in the Searchlight Section Is Duly Authorized.* Now won't **you** help keep our readers interested in this advertising by acknowledging **every** application received, even if you only return the letters of unsuccessful applicants to them marked, say, "Position filled, thank you." If you don't care to reveal your identity, mail them in plain envelopes.

We suggest this in a spirit of helpful co-operation between employers and the men replying to Positions Vacant advertisements.

Searchlight Department
McGRAW-HILL CO., Inc.
"Put Yourself in the Place of the Other Fellow"

6000

POSITIONS VACANT

Ohio

OPERATING engineer by large industrial plant for steam turbine installation. Location Ohio. State experience, when available and salary expected. P-9, Power, Leader-News Bldg., Cleveland, Ohio.

EMPLOYMENT SERVICE

SALARIED men seeking tentative offers of new connections, are invited to communicate confidentially with the undersigned, who will negotiate overtures without jeopardy to present connections. A professional, ethical service, restricted to high grade positions; established 1910. Retaining fee refunded as provided in our "Refund Contract" if service is not satisfactorily rendered as per contract, and such refund be requested within three months from date remitted. Send name and address only for particulars. R. W. Bixby, Inc., 268 Main St. (Suite 702), Buffalo, N. Y.

EXECUTIVES, engineers, find our individual confidential service effective in making new connections. Personally conducted by Mr. Jacob Penn, the eminent employment authority, known to leading business men throughout America. Refund agreement protects you. Not agency. Jacob Penn, Incorporated, 305 Broadway, New York.

POSITIONS WANTED

New York

CHIEF engineer, 15 years' experience operation and maintenance, refrigeration and power. New York State preferred. Ice or industrial plant. PW-10, Power, Tenth Ave. at 36th St., New York.

MECHANICAL and electrical engineer, wide experience in steam electric power plant and industrial equipment, design, construction, operation, efficiency tests and report work. PW-13, Power, Tenth Ave. at 36th St., New York.

Pennsylvania

OPERATING superintendent, mechanical engineering graduate with seven years' experience in operation, maintenance and installation of steam and gas engine driven gas compressors, 40,000 total engine horsepower and 22,000 total boiler horsepower handled. Open for permanent connection. PW-14, Power, Leader-News Bldg., Cleveland, Ohio.

REPRESENTATIVES WANTED

The Waite & Davey Company, Inc.,

5 Court Square, Long Island City, New York, manufacturers of a patented air cooled furnace block, walls and their construction, as well as patented air circulations for same to cover every kind of furnace, desire responsible representatives for open territory. Representative in one section made $7,000 in eight months.

PATENT ATTORNEY

C. L. PARKER, patent attorney, formerly member Examining Corps., U. S. Patent Office, McGill Bldg., Washington, D. C. Inventors' handbook sent upon request.

"Bailey's Handbook"

For Marine, Stationary and Diesel Engineers, 2200 questions and their answers taken from the lists of 419 Examiners in 39 states. 4½x6½ inches. Flexible Binding, Indexed. Sent on 10 days' approval. $2.50 per copy postpaid.

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WANTED
STEAM ENGINE
VERTICAL COMPOUND
Size 12-in. and 22-in.x11-in.
What Have You?
2812 Fairmount Ave., Atlantic City, N. J.

JET CONDENSERS

2—Schutte & Koerting Low-Level Multi-Jet Condensers, size No. 30.

1—No. 5 Allis-Chalmers Vertical Jet Condenser, with automatic vacuum breaker and 20-in. double runner submerged type water removal pump. With turbine reduction gear. Write for specifications and prices.

Nashville Industrial Corporation
Old Hickory, Tennessee

USED POWER EQUIPMENT

Released from service by a number of public utility companies

Electrical—Hydraulic—Mechanical

Our summary contains a complete list of equipment under above classification

WRITE TODAY FOR YOUR COPY B

Phoenix Utility Co., 71 Broadway, New York City

STEAM TURBOS
12500—9375—2500 Kva.
60 cy., 3 ph., Horizontal
2—New 408 Hp. 180 lb. Boilers
2—350 H.P.—175 LB. STERLING
500 650 HP. OIL ENGINES
6—600 HP. BOILERS
200 lb. with STOKERS & Sup. HTRS.
800 Kw., 250 D.C. Turbo
750 and 937 Kva. Mixed Press Turbos
480 v., 60 cy., 3 ph., with Cond.
16-in. TWIN STRAINER—Pumps.
5 to 75 T. CRANES, Spans 30-80 Ft.
ROSS POWER EQUIP. CO.
Indianapolis, Ind.

FOR SALE

1—Cochrane 8-in. figure 17 **Vertical Receiver Separator** for descending current, 125-lb. steam pressure with gauge fittings and drain valve. Price $200

1—Cochrane 600 hp. **Feed Water Heater and Purifier.** Price...$450

This is new equipment left on our hands by cancelled order.

These prices made for quick sale and are f.o.b. Milwaukee, Wis.

Allis-Chalmers Mfg. Co.
Milwaukee, Wis.

Priced for Quick Sale

Complete Steam Plant

300 kva., 2 ph., 60 cy., 2300 v. Bullock Generator direct connected to Allis-Chalmers cross compound engine. Auto transformers, 2 ph. to 3 ph. Barometric condenser with 12x16x16 steam pump.

3—270 hp. Freeman Water Tube Boilers, 155 lb. pressure, complete with feed water heater, feed pumps, forced draft fan and engine. Large stock fittings, valves, steam trap, oil separator, steam separators.

Carthage Water & Electric Plant
Carthage, Missouri

DODGE BROTHERS, Inc., DETROIT

Offer For Sale the Following

SURPLUS EQUIPMENT

POWER HOUSE EQUIPMENT
A-1 CONDITION

(Allis-Chalmers) low pressure steam turbo generator unit, 750 kw., 480 v., 3 ph., 60 cy., 1125 amp., 3600 r.p.m.

(Allis-Chalmers) 100 kw., 3600 r.p.m., 480 v., steam turbo generator.

(Allis-Chalmers) horizontal non-condensing impulse steam turbine, direct connected to centrifugal pump, 1040 r.p.m., B.H.P. 55.

(Corliss) heavy duty engine, double eccentric, non-condensing, 120 r.p.m., direct connected to type A-1 500 kva., 480 v., 3 ph., 60 cy., 602 amps. Generator (Allis-Chalmers).

C. H. Wheeler Co. Surface Condenser. Size No. 12, number 9892, 3900 sq. ft. of cooling surface, one Mullen patent suction valveless horizontal crank and flywheel steam driven vacuum pump.

Ball engine 14x18-in., four valve, direct connected to Allis-Chalmers D.C. Compound wound generator, 200 r.p.m., 120 v.

ERIE STEAM HAMMERS
6—400 lb.
8—1000 lb. In A-1 condition.
13—1500 lb.

GENERATORS
Bullock A.C. Generator, 300 kw., 440 v., 75.5 amps., 3 ph., 60 cy., 600 r.p.m. Belted type. Shop No. 9422.

G. E., A.C. Generator, 200 kw., 440 v., 534 amps., 3 ph., 60 cy., 600 r.p.m. Belted Type. Shop No. 9435.

G. E., A.C. Generator, Type A.T.B. Class 12-300-600, 3 ph., 60 cy., 50 amps., 200 kw. Shop 7651.

MOTORS
G. E. 150-hp., 181 amps., Form K, Type I, 10-150-720 (Squirrel Cage Type) Standard Shaft.

G. E. 50-hp., 660 r.p.m., 220 v., 190 amps. D.C. shunt wound.

1—Williams No. 4 Coal Crusher.

2—Jeffries Type "A" Pulverizers, A-1 condition.

Address All Inquiries to

WASTE MATERIAL SALES DIVISION
DODGE BROTHERS, Inc., DETROIT

R. SCHEINERT COMPANY
"Everything in Electric Power Machinery"
123-125 N. Third St., Philadelphia, Pa.

100 kva. Westinghouse-Harrisburg Engine Generator Unit, 3 ph., 60 cy., 2300 v., 277 r.p.m.

75 kva. Westinghouse-Harrisburg Engine Generator Unit, 3 ph., 60 cy., 2300 v., 277 r.p.m.

150 kva. Fort Wayne Generator, 3 ph., 600 r.p.m.

150 kva. Westinghouse Generator, 3 ph., 900 r.p.m.

85 kva. Westinghouse Generator, 2 ph., 720 r.p.m.

75 kva. Westinghouse Generator, 2 ph., 900 r.p.m.

75 kva. Crocker-Wheeler Generator, 2 ph., 900 r.p.m.

5 kva. Westinghouse Generator, 1 ph., 1800 r.p.m.

2 kva. Wagner Generator, 1 ph., 1800 r.p.m.

FOR SALE
80 H.P. BESSEMER OIL ENGINE
Fine condition. Ask for Nels.
WEST END MFG. CO.
2184 Canal Port Ave., Chicago, Ill.

TO HELP YOU
GET WHATEVER YOU NEED
"Searchlight" Advertising
G-4

"Congratulations are in order for the publicity Power has given us. You have proven results"

This company had boilers, engines, generators and compressors to sell.

What Have You To Sell?

you too can locate quick buyers for your equipment
by advertising it in the

SEARCHLIGHT SECTION of POWER

TURBINES

2—62.5 kva., 2300 volt, 3 phase, 60 cycle, 1200 r.p.m., Westinghouse generator with 2 kw., 125 volt, direct connected exciter, coupled through reduction gear to Westinghouse steam turbine, 3600 r.p.m.

3—75 kw., 250 volt, General Elec. type C-4, turbo generators.

1—150 kw. (187.5 kva.), Westgh. 2300 volt, 3 phase, 60 cycle, 3600 r.p.m. to Westgh. non-condensing turbine No. 150; with switchboard.

1—200 kw., form C, Gen. Elec. turbine, 125 lbs. steam, non-condensing, to a 200 kw., 600 volt, 3 phase, 60 cycle, 3600 r.p.m., General Elec. generator (rigid frame type) direct connected exciter and switchboard.

2—200 kw., 3 phase (2 phase), 60 cycle, 480 volt, Crocker-Wheeler generator, 600 r.p.m., connected to DeLaval steam turbine, non-condensing, 150 lbs. steam, 10 lbs. back pressure with switchboard.

1—250 kva., unused, 220 volt, 3 phase, 60 cycle, 3600 r.p.m., Allis-Chalmers to a Moore condensing type turbine and direct connected exciter.

1—300 kw. (375 kva.), rigid frame type, 2300 volt, 3 phase, 60 cycle, condensing type, with Schutte & Koerting condenser.

1—300 kw., 410 volt, 3 phase, 60 cycle, 3600 r.p.m., Westinghouse generator to a Westinghouse-Parsons steam turbine with Wheeler Condenser & Engineering Company's Admiralty type condenser. Also Blue Vermont marble panel for generator with necessary meters, switch and rheostat.

1—300 kw., Westinghouse direct current generator, 900 r.p.m., Serial No. 1,821,519, 900 r.p.m., 500 amp., 550/600 volts, direct connected to No. 3292 Westinghouse steam turbine, 6,000 r.p.m., non-condensing.

This turbo generator could be used for belt drive by using pulley in place of generator. A new alternating current generator could be bought to replace the direct current machine and make a cheap and very fine unit.

1—600 kw. (750 kva.), 2300 volt, 3 phase, 60 cycle, 3600 r.p.m., NEW General Elec. turbo generator unit.

1—600 kw. (750 kva.), 480 volt, 3 phase, 60 cycle, 3600 r.p.m., NEW General Elec. turbo generator unit.

1—1000 kw., .80 P.F., type ATB-2-120-3600, form T, 3600 r.p.m., 3 phase, 60 cycle, 2300 volt, General Electric generator direct connected to 1000 kw. Curtis turbine.

1—1000 kw., .80 P.F., 2300 volt, 3 phase, 60 cycle, Ridgeway generator direct connected to a Ridgeway Rateau Smoot turbine complete with C. H. Wheeler Mfg. Co. condenser.

1—1000 kw., 2 phase, 60 cycle, 2100 volt, 3600 r.p.m. (Can be connected 3 phase), General Elec. to 1000 kw., General Electric Curtis turbine with Spiro-flo Jet Condenser and Switchboard.

1—1000 kw., 250 volt, 3 wire, 511 r.p.m., Westinghouse, generator connected through reduction gear to Westinghouse condensing type turbine, at 3600 r.p.m. No switchboard or condenser.

GEO. SACHSENMAIER CO.
924 N. Third St. Philadelphia, Pa.

$$ SAVE $$

TURBINES

500 K.W. ALLIS CHALMERS
2300 VOLTS 3 PHASE 60 CYCLES
157 AMPERES 3600 R.P.M.
COMPLETE WITH EXCITER, JET CONDENSER, VACUUM PUMP AND ALL ACCESSORIES
$ 6,000 F.O.B. CARS

2-125 K.V.A. WESTINGHOUSE
2300 VOLTS 3 PHASE 60 CYCLES
TURBINE 7200 R.P.M. GENERATOR 900 R.P.M.
COMPLETE WITH EXCITER AND ACCESSORIES
$ 2,000 EACH F.O.B. CARS

2-100 K.W. G.E. CURTIS
480 VOLTS 2 PHASE 60 CYCLES
130 AMPERES 3600 R.P.M.
DIRECT-CONNECTED EXCITERS AND ALL ACCESSORIES
$1,000 EACH F.O.B. CARS

OKLAHOMA HIGH LINE CONSTRUCTION CO.
OFFICE AND WAREHOUSE
115 EAST ARCHER TULSA, OKLA.
SOUTHWEST'S PIONEER MACHINERY HOUSE

BOILERS

SPECIAL BARGAINS

500 H.P. B. & W.
2—500 Hp. B.&W., 200 lbs. pressure, Chain Grate Stokers. Fine condition.

295 H.P. Stir.
3—295 Hp. Stirling Class S, No. 15 A. S. M. E. Chain Grate Stokers.

Act quickly or you'll miss these bargains. The equipment is in wonderful condition, in fact they are THE BEST BOILERS I EVER HANDLED. They'll insure a saving and yet give new boiler performance.

HERE IS A LARGE SELECTION—THEY'RE ALL GOOD

No.	Hp.	Make	Pressure Lbs.
3	600	Edge Moor	175
3	512	Stirling Class S No. 26	160
2	550	Edge Moor	150
2	389	Heine	150
3	389	Heine	160
1	440	Edge Moor	145
1	400	Stirling	150
2	400	Wickes	150
1	250	Wickes	150
1	300	Wickes	150
1	300	Edge Moor	125
1	200	Scotch Marine	160
1	320	B. & W.	150
1	362	Stirling	200
16—72 x 18 in.		150 H.R.T.	125
1—72 in x 18 ft.		150 H.R.T.	120

Other sizes and makes available **Let Davis furnish the boilers!**

J. F. DAVIS
1122-4 Harris Trust Bldg.
CHICAGO, ILL.

Taylor Stokers 1200 H.P.
Brand New Never Used
Each outfit will serve a 550-600-hp. water tube boiler. Makers specifications, photo and bargain price on request.
GENERAL EQUIPMENT CO.
Gridley Bldg., Syracuse, N. Y.

ELECTRICAL MACHINERY
POWER EQUIPMENT
WHEN IN THE MARKET FOR ELECTRIC MOTORS, BOILERS, AIR COMPRESSORS, PUMPS AND EQUIPMENT THINK OF
"O'BRIEN"
PHILADELPHIA
The O'Brien Machinery Co.
113 North Third Street, Philadelphia, Pa.
Long Distance Telephone: Market 0727
Cable Address: OBRIEN Philadelphia

WINTER—means Cooling Tower trouble!

Are you troubled with ice formation on your fan blades during winter months? Don't remove the blades—that's no remedy! It only cuts down the capacity of your tower.

Brownell Engineers eliminated ice formation on the fans of seven towers at the Winchester Repeating Arms, New Haven plant, *and increased the operating efficiency of the towers at least 13% through all seasons of the year!* This change was made by Brownell Engineers 8 years ago, and has proven most satisfactory ever since. Let us solve *your* condenser troubles.

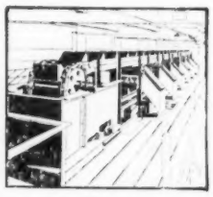
G. W. Brownell Engineering Corp.
Woolworth Bldg., New York

SPECIAL BARGAIN
Reconditioned Condenser
Worthington — 8,500 sq. ft., 1-in.—18 B. W. G. tubes with new auxiliaries. *A real bargain* if you can use it.

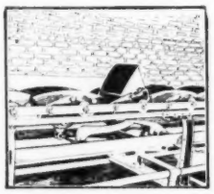
General Power Equipment
BOILERS GENERATORS
ENGINES MOTORS
HOOPER-MOMBERGER CO.
90 West St., N. Y.

POWER PLANT EQUIPMENT
GOOD USED
Transformers
Generator Units
Motors Rotaries
Frequency Sets
Motor Generators
Turbines Engines
Boilers Pumps
Condensers
Moore & MacDonald
26 Cortlandt St., New York

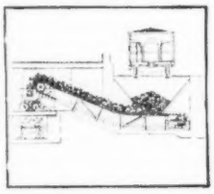
Equipment for Every Coal Handling Need



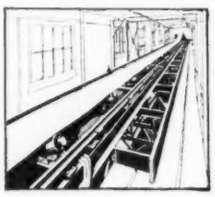
Bucket Elevators and Conveyors



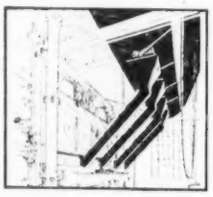
Pivoted Bucket Carriers



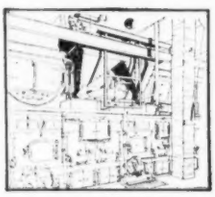
Track Hoppers and Feeders



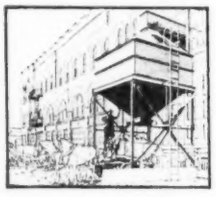
Belt Conveyors



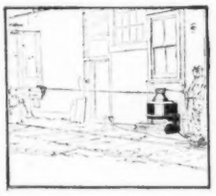
Bunkers, Gates, Spouts



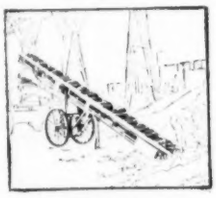
Weighing Larries



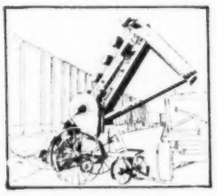
Ash Handling Equipment



Electric Capstan Car Pullers

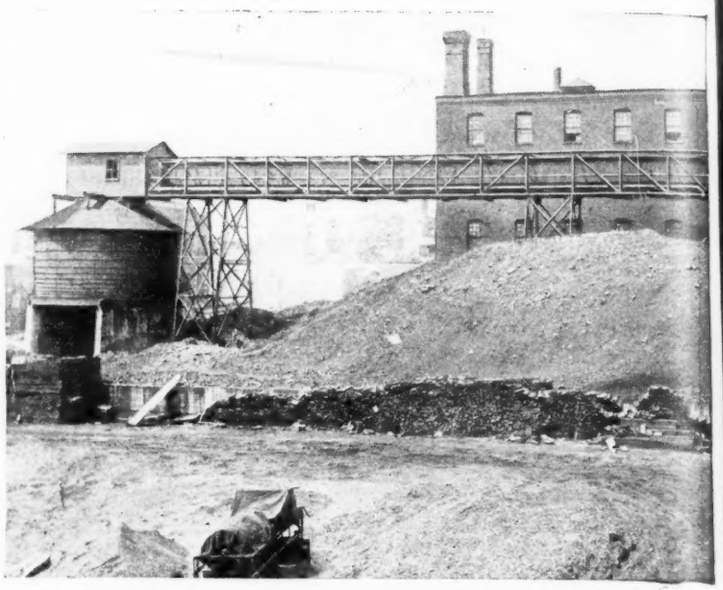


Portable Belt and Flight Conveyors



Portable Wagon Loaders

Handles



Ground Storage Coal Handling Plant of Phoenix Mills, Inc.; Little Falls, N. Y. Designed and equipped by Gifford-Wood Company.

IN ADDITION to effecting a 75% saving in handling cost, this G-W Coal Handling Plant enables the Phoenix Mills, Inc., to purchase and store coal at seasonable periods when prices are most favorable.

It also provides facilities for storing coal against possible shortages: 4,000 tons, over a four months' supply, can be stored if needed.

Uninterrupted service and low maintenance is insured by exceptionally sturdy construction—an important feature of all G-W Equipment. Although put into operation seven years ago, this plant has never broken down nor caused even a single cent of repair expense.

GIFFORD-WOOD COMPANY

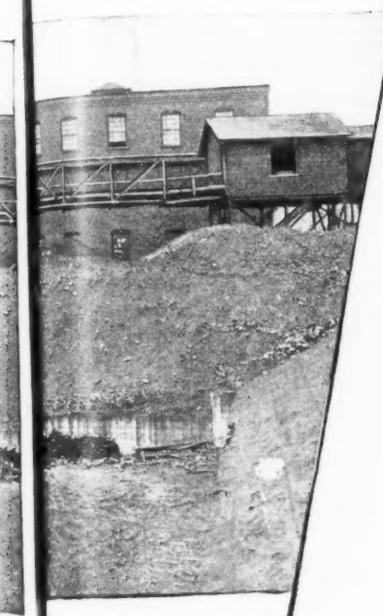
Main Office: 17 Hill St., Hudson, N. Y.

New York: 50 Church Street
Boston: 222 State Street
Chicago: 565 W. Washington St.
Pittsburgh: Peoples Bank Bldg.
Works: Hudson, N. Y.

Gifford

ECONOMICAL COAL HANDLING

Coal at ¼ former cost!



PHOENIX MILLS, INC.
MANUFACTURERS OF
KNITTED FABRICS
AND
GARMENTS
LITTLE FALLS, N.Y.

Gifford-Wood Co.,
Hudson, N. Y.

Gentlemen:

In reply to your letter of July 31st, I am glad to advise you that our Gifford-Wood Coal Handling Equipment, which was installed seven years ago, has proved highly satisfactory.

With this equipment, and only one man, we unload and store about 15,000 tons of coal a year.

Before the equipment was installed, our coal was handled on contract by an outside firm but we found this method of handling too expensive. I should say that a conservative estimate would be that our equipment handles our coal at about one quarter the former cost.

As to repair expense: there has been none.

Very truly yours,
PHOENIX MILLS, INC.,
M. B. Shefferdson
President.

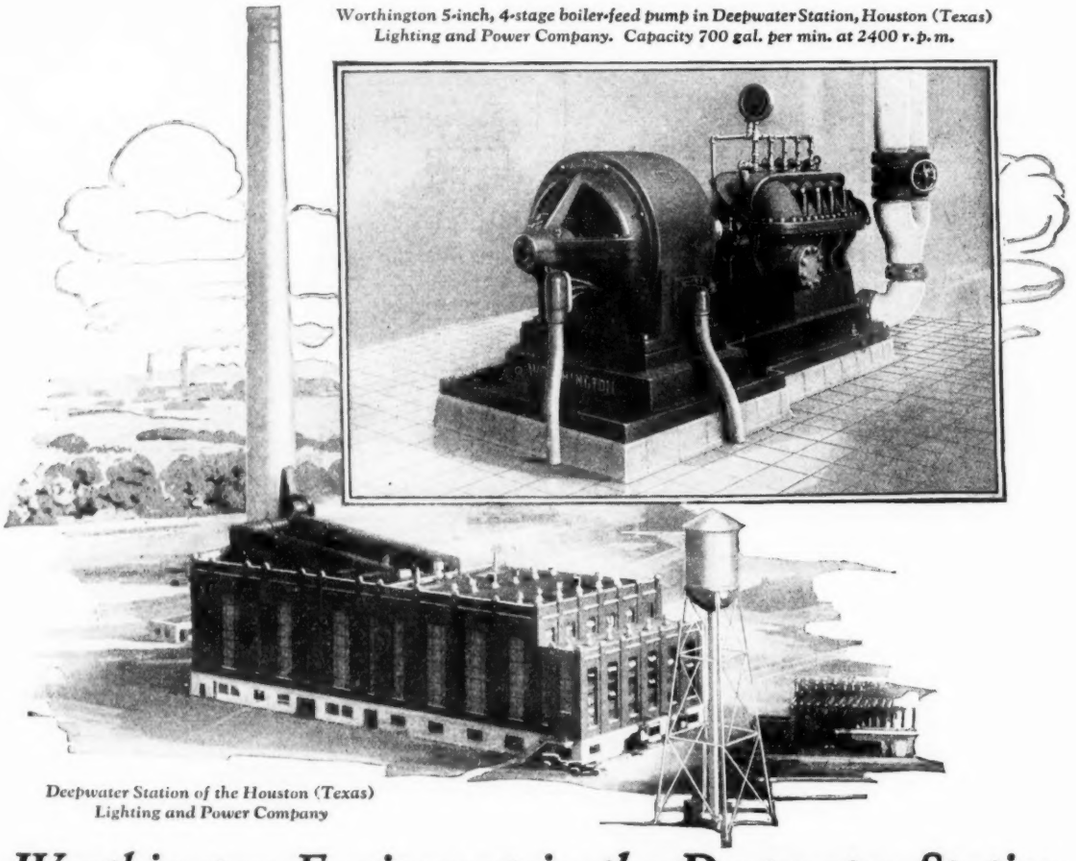
WBS:A

Wood

BUILT STRONGER LASTS LONGER

2432-R

EQUIPMENT *for* ALL PURPOSES



Worthington 5-inch, 4-stage boiler-feed pump in Deepwater Station, Houston (Texas) Lighting and Power Company. Capacity 700 gal. per min. at 2400 r.p.m.

Deepwater Station of the Houston (Texas) Lighting and Power Company

Worthington Equipment in the Deepwater Station of the Houston Lighting and Power Company

IN the new Deepwater Station of the Houston (Texas) Lighting and Power Company, Worthington pumps are used on many of the most important applications. The principal Worthington equipment consists of:

Three 5-inch 4-stage turbine boiler-feed pumps
Two centrifugal condensate pumps
Two centrifugal raw-water pumps for evaporator
Four double-suction volute pumps for handling cooling water for evaporator
One duplex, vertical piston fuel-oil pump
One "FEATHER" Valve air compressor

The Houston Lighting and Power Company has been a consistent user of Worthington equipment. Five turbine boiler-feed pumps, a compressor and condensing apparatus were among the equipment supplied to their old Gable Street Power Station. One of the Worthington turbine boiler-feed pumps in this station has been in practically continuous operation for 18 years.

Whether it be pumps, compressors, feed-water heaters, condensers or Diesel-oil engines in which you are interested, the merits of the Worthington line warrant your most careful investigation.

WORTHINGTON PUMP AND MACHINERY CORPORATION
115 BROADWAY, NEW YORK BRANCH OFFICES IN 24 CITIES

WORTHINGTON

4618-3

The NEW YORK EDISON CO. Selects

SPRINGFIELD BOILERS

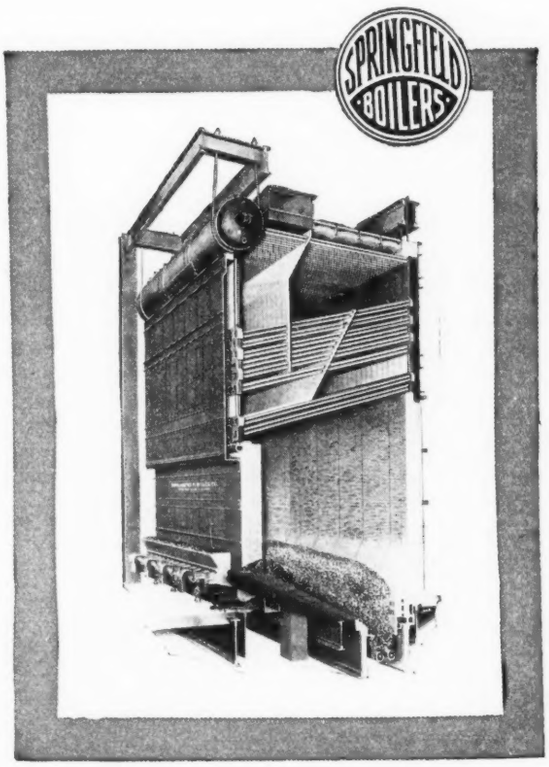
for their new EAST RIVER STATION being built at 14th Street and East River, New York City.

In the design and equipment of this new mammoth Generating Station, the New York Edison Co., through their Engineers, Thos. E. Murray, Inc., who have had vast experience with SPRINGFIELD boilers, decided on these boilers and the initial installation will consist of Ten 1550 H.P. Boilers built for an operating pressure of 425 pounds.

Leading Engineers and Power Users everywhere are adopting SPRINGFIELD BOILERS which are

SECTIONAL — ALL STEEL

Built in All Sizes and for All Pressures
EACH handhole covers FOUR tubes



Repeat orders constitute a large share of our business

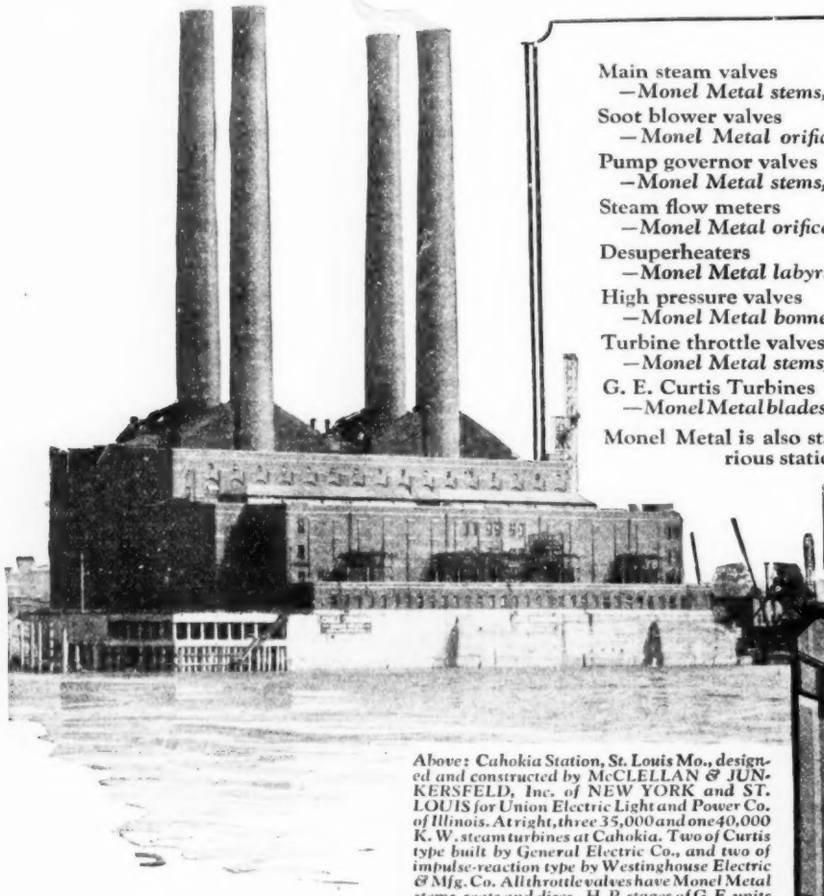
Springfield Boiler Co.

Springfield, Illinois

OFFICES:

Chicago
New York
Boston
Philadelphia
Pittsburgh
Richmond
Atlanta
Cincinnati
Buffalo
Detroit
Duluth
Minneapolis
Kansas City
Seattle
Los Angeles
San Francisco

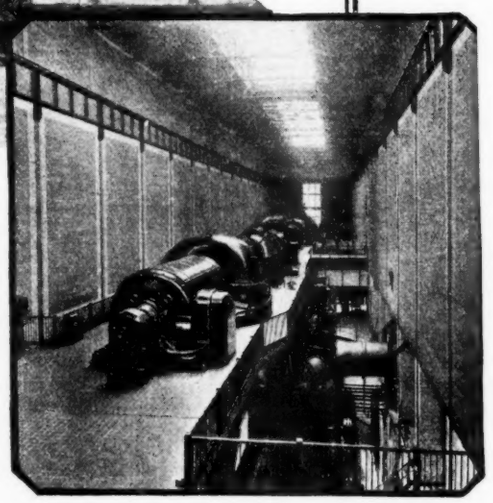
and at CAHOKIA STATION –



Main steam valves
—*Monel Metal stems, seats and discs*
Soot blower valves
—*Monel Metal orifice plates, seats and discs*
Pump governor valves
—*Monel Metal stems, seats and discs*
Steam flow meters
—*Monel Metal orifice plates*
Desuperheaters
—*Monel Metal labyrinth cartridges*
High pressure valves
—*Monel Metal bonnet gaskets*
Turbine throttle valves
—*Monel Metal stems, seats and discs*
G. E. Curtis Turbines
—*Monel Metal blades and shrouding on H. P. stages*

Monel Metal is also standard for vital parts of various station instruments.

See the Monel Metal Exhibit at the Chicago Power Show



Above: Cahokia Station, St. Louis Mo., designed and constructed by McCLELLAN & JUNKERSFELD, Inc. *of* NEW YORK *and* ST. LOUIS *for Union Electric Light and Power Co. of Illinois. At right, three 35,000 and one 40,000 K. W. steam turbines at Cahokia. Two of Curtis type built by General Electric Co., and two of impulse-reaction type by Westinghouse Electric & Mfg. Co. All throttle valves have Monel Metal stems, seats and discs. H. P. stages of G. E. units fitted with Monel Metal blades and shrouding.*

McClellan & Junkersfeld, Inc. Specified Monel Metal

AT Cahokia Station of the Union Electric Light and Power Co. of Illinois—as in most power plants using superheated steam—Monel Metal was specified for vital parts because it fills the need for a super-metal—a metal that stands up under the high pressures and temperatures incident to super-heat service.

The combination of Monel Metal's steel-like strength with its toughness and corrosion-resistance shows power plant engineers the way to many worthwhile operating economies. By using Monel Metal for vital parts, YOU can safeguard equipment against the erosive and wire-cutting action of superheated steam and the corrosive attacks of salty and acid waters.

Uninterrupted service is essential to most large power plants. Dependable Monel Metal parts help make such service possible. Such is the experience of the country's foremost engineering authorities.

If you expect economical and continuous service from your super-heat equipment, we suggest that you insure dependability by making it standard practice to specify Monel Metal. Let us send you full information.

ASK FOR "LIST B" OF MONEL METAL & NICKEL LITERATURE
THE INTERNATIONAL NICKEL COMPANY
67 WALL STREET NEW YORK CITY

INCo Monel metal

Monel Metal is a technically controlled, uniform Nickel-Copper alloy of high nickel content. It is mined, smelted, refined, rolled and marketed solely by The International Nickel Company. The name "Monel Metal" is a registered trade mark.

CAN'T SELL YOU A BABY COACH IF YOU DON'T HAVE A BABY!

If you don't have Steam (or Air)
We can't sell you a Ridgway Elevator.

BUT IF YOU HAVE STEAM—

OH, BOY!

We give you the Most Perfect thing in elevators the world has ever seen—

NO FIRE IN THE HATCH TO BURN YOU OUT
Plants are going up in smoke from Elevator fires every day.

NO COUNTERWEIGHTS TO MENACE LIFE
Killing folks all the time. New laws will require boiler plate casings for weights in the future.

NO OVERLOADING AND SUBSEQUENT BREAK DOWNS
"3 killed and 7 injured" the other day. Load on Ridgway Elevator never more than diameter cylinder multiplied by the steam pressure.

NO GOING INTO THE OVERHEAD
There can be no overtravel with the Ridgway Elevator. Piston bottoms on cylinder heads.

NO REPAIRS
The longer a Ridgway Elevator is used the better it gets. There is nothing to wear out or repair.

NO FAILING TO FUNCTION
Nothing puts the Ridgway Elevator out of the running but the boiler blowing up. When the engine shuts down the Ridgway goes just the same.

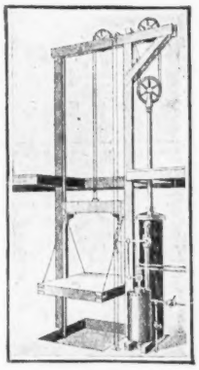
NO COST TO RUN
Steam used is so trifling the fireman does not burn one ounce more fuel for the Ridgway Elevator. Any school boy can test this statement.

If you get the above into your system you will know why it is the big fellows all over the land

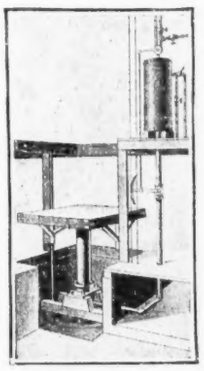
"HOOK 'ER TO THE BILER"

Craig Ridgway & Fils Co.

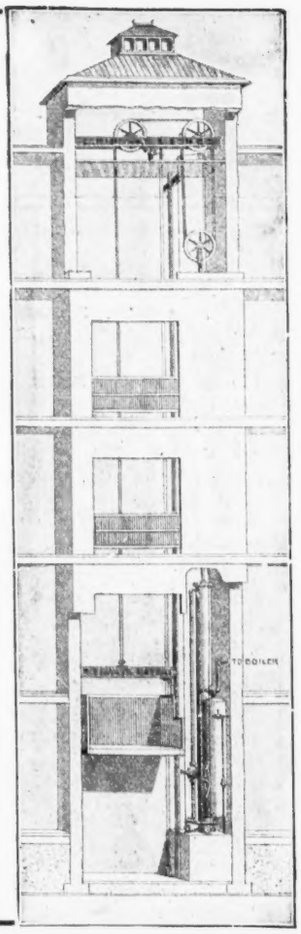
Elevator Makers to the folks who know COATESVILLE, PA.



Double Geared



Direct Acting



A few of the many reasons why you should investigate

LADD Water Tube Boilers

before extending your present equipment:—

Can be built as a single unit in any size to upward of 9000 rated horsepower.

Designed to meet all special conditions—such as size, space, fuel burning equipment and other limitations.

May be operated with any type of modern stoker equipment, with Blast Furnace or Natural Gas, with Powdered Fuel or various combinations of these fuels.

Exceptionally large drums mean more working space, more water storage and steam liberating area.

Scale making substance and sediment are confined to coolest part of the boiler.

A large combustion chamber makes for complete burning of all volatile gases while front bank of tubes is exposed to the radiant heat of the fire.

Has neither stay bolts nor flat surfaces.

Any tube can be removed without taking out key tube.

Ladd Water Tube Boilers hold the world's record for maximum power developed from a single unit.

THE LADD WATER TUBE BOILER COMPANY

CHICAGO OFFICE
528 McCormick Bldg.

First National Bank Bldg.
PITTSBURGH, Penna.

NEW YORK OFFICE
39 Cortlandt St.

This Company will exhibit in Booth No. 419 at the Chicago Power Show — Jan. 26th to Jan. 30th, 1926.

WATER TUBE LADD BOILER

(Our New Catalogue No. 23 will be sent on request).

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names and Addresses of Manufacturers and Distributors

See Last Page for Alphabetical Index

Aftercoolers and Receivers, Air
Chicago Pneumatic Tool Co., N. Y.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee

Air Chambers
Hercules Float Wks., Springfield, Mass.

Air Washers
Hardinge Co., York, Pa.
Spray Engineering Co., Boston

Alternators, Turbo
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Terry Steam Turbine Co., Hartford

Arches, Boiler Door
McLeod & Henry Co., Troy, N. Y.

Arches, Flat, Suspended
Bernitz Furnace Appliance Co., Boston
Bigelow Arch Co., Detroit
Botfield Refractories Co., Phila.
Brady Conveyors Corp., Chicago
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Ash Gates and Hoppers for Pulverized Fuel
Allen, Sherman, Hoff Co., Phila.
Jeffrey Mfg. Co., Columbus, O.

Ash Handling Equipment
Allen, Sherman, Hoff Co., Phila.
Barber-Greene Co., Aurora, Ill.
Beaumont Co., R. H., Phila.
Brady Conveyors Corp., Chicago
Combustion Engrg. Corp., N. Y.
Conveyors Corp. of Am., Chicago
Detrick Co., M. H., Chicago
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
McMyler-Interstate Co., Cleveland
Robins Conveying Belt Co., N. Y
United Conveyors Corp., Chicago
Webster Mfg. Co., Chicago

Ash Quenchers
Allen, Sherman, Hoff Co., Phila.

Ash Sluicing Systems
Allen, Sherman, Hoff Co., Phila.

Ash Tanks, Cast Iron
Conveyors Corp. of Amer., Chicago

Ash Tanks, Steel
Heine Boiler Co., St. Louis

Ash Tanks, Tile
United Conveyors Corp., Chicago

Baffle Walls, Boiler
Betson Plastic Fire Brick Co., Rome, N. Y.
Boiler Engineering Co., Newark, N.J.
Engineer Co., N. Y.
King Refractories Co., Buffalo
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Baffles, Monolithic
Betson Plastic Fire Brick Co., Rome, N. Y.
Boiler Engineering Co., Newark, N.J.
King Refractories Co., Buffalo

Belting
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.

Belting, Conveyor
Jeffrey Mfg. Co., Columbus, O.
Keasbey & Mattison Co., Ambler, Pa.
N. Y. Belting & Packing Co., N. Y.

Belting, Rubber
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Bins
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland

Blowers, Centrifugal
De Laval Steam Turbine Co., Trenton
Elliott Co., Wellsville, N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Fan
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Engineer Co., N. Y.
General Electric Co., Schenectady
Green Fuel Economizer Co., Beacon, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Forced Draft
Air Preheater Co., N. Y.
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Jeffrey Mfg. Co., Columbus, O.
McClave-Brooks Co., Scranton, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., N. Y.

Blowers, Induced Draft
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Jeffrey Mfg. Co., Columbus, O.
Prat-Daniel Corp., N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Blowers, Soot, for Boiler Tubes
Huyette Co., Paul B., Phila.
Marion Machine Foundry & Supply Co., Marion, Ind.
Vulcan Soot Cleaner Co., Webster Bldg., Du Bois, Pa.

Blowers, Steam Jet
Chesterton Co., A. W., Boston
McClave-Brooks Co., Scranton, Pa.
Schutte & Koerting Co., Phila.

Blowers, Turbine
Coppus Engineering Corp., Worcester, Mass.
Elliott Co., Wellsville, N. Y.
Ingersoll-Rand Co., N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford
Wing Mfg. Co., L. J., N. Y.

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Paige & Jones Chemical Co., Hammond, Ind.

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McClave-Brooks Co., Scranton, Pa.

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Keasbey & Mattison Co., Ambler, Pa.

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Ballard, Sprague & Co., N. Y.
Bernitz Furnace Appliance Co., Boston
Betson Plastic Fire Brick Co., Rome, N. Y.
Botfield Refractories Co., Phila.
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CoKal Stoker Corp., Chicago
Custodis Chimney Constr. Co., Alphons, New York
Detrick Co., M. H., Chicago
Erie City Iron Wks., Erie, Pa.
Illinois Stoker Co., Alton, Ill.
Liptak Fire Brick Arch Co., Mexico, Mo.
Naismith & Sons, Geo., Pittsburgh
Plibrico Jointless Firebrick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Rust Engineering Co., Pittsburgh
Walsh Fire Clay Products Co., St. Louis

Boiler Tube Cleaners
(See Blowers, Soot, for Boiler Tubes)
(See Scale Removers)
(See Tube Cleaners Boiler)

Boilers, Cross-Drum
Babcock & Wilcox Co., N. Y.
Brunswick-Kroeschell Co., Chicago
Edge Moor (Del.) Iron Co.
Heine Boiler Co., St. Louis
Springfield (Ill.) Boiler Co.
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Boilers, Heating
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Stanwood Corp., Cincinnati

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Erie City Iron Works, Erie, Pa.
Stanwood Corp., Cincinnati

Boilers, Return Tubular
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Connery & Co., Phila.
Delany & Co., P., Newburgh, N. Y.
Erie City Iron Wks., Erie, Pa.
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Stanwood Corp., Cincinnati
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga

Boilers, Vertical Water Tube
Babcock & Wilcox Co., N. Y.
Casey-Hedges Co., Chattanooga
Erie City Iron Works, Erie, Pa.
Wickes Boiler Co., Saginaw, Mich

Boilers, Waste Heat
Edge Moor (Del.) Iron Co.

Boilers, Water Tube
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Brunswick-Kroeschell Co., Chicago
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Heine Boiler Co., St. Louis
Kidwell Boiler Co., Milwaukee
Ladd Water Tube Boiler Co.
Springfield (Ill.) Boiler Co.
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Vogt Machine Co., Henry, Louisville
Walsh & Weidner Boiler Co., Chattanooga
Wickes Boiler Co., Saginaw, Mich.

Bolts, Nuts, Monel Metal & Nickel
International Nickel Co., N. Y.

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Kidwell Boiler Co., Milwaukee
Smith & Sons Co., S. Paterson, N. J.

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Bernitz Furnace Appliance Co., Boston
Betson Plastic Fire Brick Co. Rome, N. Y.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

Bucket Carrier, Pivoted
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago

Buckets, Clam Shell
American Hoist & Derrick Co., St. Paul, Minn.
Blaw-Knox Co., Pittsburgh
Brown Hoisting Machinery Co., Cleveland
Hayward Co., N. Y.
Link-Belt Co., Chicago
McMyler-Interstate Co., Cleveland

Buckets, Electric Motor
Hayward Co., N. Y.

Buckets, Orange Peel
Hayward Co., N. Y.
McMyler Interstate Co., Cleveland

Buildings Portable Steel
Blaw-Knox Co. Pittsburgh

Bunkers, Coal
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Conveyors Corp. of Am., Chicago
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Burners, Oil
Coen Co., San Francisco
Combustion Engrg. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.
Schutte & Koerting Co., Phila.

Car Pullers, Electric Capstan and Hand
Gifford-Wood Co., Hudson, N. Y.
Webster Mfg. Co., Chicago

Castings, Brass & Iron
Neemes Foundry, Inc., Troy, N. Y.

Castings, Grey Iron
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Harrisburg (Pa.) Fdy. & Mach. Wks.
Hooven, Owens, Rentschler Co., Hamilton, O.
Riley Stoker Corp., Worcester

Castings, Monel Metal & Nickel
International Nickel Co., N. Y.

Cement, Fire Brick
Ashland (Ky.) Fire Brick Co.
Betson Plastic Fire Brick, Rome, N. Y.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
King Refractories Co., Buffalo
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago
Walsh Fire Clay Products Co., St. Louis

Cement Guns
Cement Gun Co., Allentown, Pa.

Cement, Iron
Smooth-On Mfg. Co., Jersey City

Cement, Pipe Joint
Smooth-On Mfg. Co., Jersey City, N. J.

Chain Drive
Jeffrey Mfg. Co., Columbus, O.
Morse Chain Co., Ithaca, N. Y.

Chain, Monel Metal
International Nickel Co., N. Y.

Chimneys (See Stacks)

Clamps, Pipe
Yarnall-Waring Co., Mermaid Ave., Phila.

Clutches, Friction
Gifford-Wood Co., Hudson, N. Y.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Coal
Peale, Peacock & Kerr, N. Y.
Pittsburgh (Pa.) Coal Co.

Coal Bunker Lining
Wailes Dove-Hermiston Corp., N. Y.

Coal Crushers
American Pulverizer Co., St. Louis
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Erie City Iron Wks., Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Coal Drying Equipment
Hardinge Co., York, Pa.

Coal Handling Equipment
American Hoist & Derrick Co., St. Paul, Minn.
Barber-Greene Co., Aurora, Ill.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Hayward Co., N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
McMyler Interstate Co., Cleveland
Robins Conveying Belt Co., N. Y.
Sauerman Bros., Chicago
Webster Mfg. Co., Chicago

Cocks, Gage
Defender Automatic Regulator Co., St. Louis
Huyette Co., Paul B., Phila.
Jenkins Bros., N. Y.
Nason Mfg. Co., N. Y.

Cocks, Steam
Dart Mfg. Co., E. M., Providence
Lunkenheimer Co., Cincinnati

Combustion Chamber, Back Arch
Betson Plastic Fire Brick Co., Rome N. Y.
Detrick Co., M. H., Chicago
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St Louis

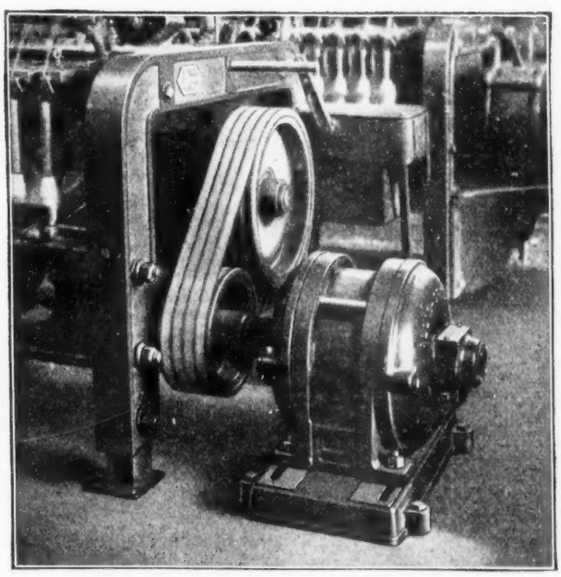
Combustion Control System
Smoot Engr. Corp., N. Y.

CO_2 Recorders and Flue Gas Analysis Instruments
Brown Instrument Co., Phila.
Huyette Co., Paul B., Phila.
Permutit Co., N. Y.

ALLIS TEXROPE DRIVES

PATENTS PENDING

The Balloon Tires of Industry



**Where Smoothness Is Paramount—
Allis Texrope Drive Applied to Cotton Twister**

Like Balloon Tires, Texrope Drives carry the loads without transmitting the shocks and jars. They are smooth and flexible, yet slipless, powerful and durable. In addition, they are silent, clean, simple, troubleproof and not affected by moisture, dust and dirt.

Just as Balloons are replacing high pressure, unyielding tires, Texrope Drives are replacing unflexible short center drives and space wasting long center drives thruout industry.

Write for Bulletin 1228

ALLIS-CHALMERS MANUFACTURING COMPANY
MILWAUKEE, WISCONSIN. U.S.A.

District Offices in All Leading Cities

Compressors, Air
Allis-Chalmers Mfg. Co., Milwaukee
Bury Compressor Co., Erie
Gardner-Governor Co., Quincy, Ill.
General Electric Co., Schenectady
Hooven, Owens, Rentschler Co., Hamilton, O.
Ingersoll-Rand Co., N. Y.
Nordberg Mfg. Co., Milwaukee
Sullivan Machinery Co., Chicago
Worthington Pump & Machy. Corp., N. Y.

Compressors, Ammonia
Ingersoll-Rand Co., N. Y.
Worthington Pump & Machy. Corp., N. Y.

Compressors, Gas
Bury Compressor Co., Erie
Worthington Pump & Machy. Corp., N. Y.

Compressors, Extraction
Sullivan Machinery Co., Chicago

Compressors, Gasoline
Sullivan Machinery Co., Chicago

Condensers
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Kellogg Co., M. W., N. Y.
Nordberg Mfg. Co., Milwaukee
Ross Heater & Mfg. Co., Buffalo.
Schutte & Koerting Co., Phila.
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Barometric and Combined
Buffalo Steam Pump Co., Buffalo
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.

Condensers, Jet
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Condensers, Surface
Elliott Co., Jeannette, Pa.
Ingersoll-Rand Co., N. Y.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Conduits, Underground
Woodwell, J. E., N. Y.

Controllers, Draft
Engineer Co., N. Y.

Controllers, Electric
General Electric Co., Schenectady

Conveyors, Belt
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O
Link-Belt Co., Chicago
Robins Conveying Belt Co., N. Y.
Webster Mfg. Co., Chicago

Conveyors, Portable
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago

Coolers, Generator
Griscom-Russell Co., N. Y.
Schutte & Koerting Co., Phila.
Spray Engineering Co., Boston
Sturtevant Co., B. F., Hyde Park, Mass.

Coolers, Oil
Griscom-Russell Co., N. Y.
Schutte & Koerting Co., Phila.

Coolers, Water
Badger & Sons, Co., E. B., Boston
Ross Heater & Mfg. Co., Buffalo
Vogt Mach. Co., Henry, Louisville

Cooling Plants and Ponds
Badger & Sons, Co., E. B., Boston
Binks Spray Equip. Co., Chicago
Schutte & Koerting Co., Phila.
Spray Engineering Co., Boston
Yarnall-Waring Co., Mermaid Ave., Phila.

Cooling Towers
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Couplings, Flexible Shaft
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Terry Steam Turbine Co., Hartford

Couplings, Shaft
Foote Bros. Gear & Mach. Co., Chicago
Jeffrey Mfg. Co., Columbus, O.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Covering, Boiler
Betson Plastic Fire Brick Co., Rome, N. Y.
Bethlehem (Pa.) Shipuilding Corp.
Keasbey & Mattison Co., Ambler, Pa.

Covering, Pipe
Bethlehem (Pa.) Shipuilding Corp.
Keasbey & Mattison Co., Ambler, Pa.

Cranes
American Hoist & Derrick Co., St. Paul, Minn.
Brown Hoisting Machinery Co., Cleveland

Cranes, Crawler Type
Link-Belt Co., Chicago
McMyler-Interstate Co., Cleveland

Cranes, Locomotive Gas
Brown Hoisting Machinery Co., Cleveland

Cranes, Locomotive Steam
American Hoist & Derrick Co., St. Paul, Minn.
Brown Hoisting Machinery Co., Cleveland
Link-Belt Co., Chicago
McMyler Interstate Co., Cleveland

Cut Outs, Electric
General Electric Co., Schenectady

Cutters, Boiler Tubes
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Hooven, Owens, Rentschler Co., Hamilton, O.
Underwood Corp., H. B., Phila.

Dampers
Clarage Fan Co., Kalamazoo, Mich.

Deaerators
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Ross Heater & Mfg. Co., Buffalo

Dealers Machinery
(See Searchlight Section)
Allis-Chalmers Mfg. Co.
Brownell Engr. Co., G. W.
Davis, J. F.
Industrial Plants Corp.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Oklahoma High Line Constr. Co.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Scheinert Co., R.
West End Mfg. Co.

Die Stocks
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach.

Distilling Apparatus (Water)
Griscom-Russell Co., N. Y.

Doors, Ash Pit
Brady Conveyors Corp., Chicago

Draft, Mechanical
(See Blowers, Fan)

Drainers, Low Pressure
Cochrane Corp., Phila.

Dressing, Belt
Keystone Lubricating Co., Phila.

Drills
Chicago Pneumatic Tool Co., N. Y.

Drop Forgings
Ingersoll-Rand Co., N. Y.
Jeffrey Mfg. Co., Columbus, O.
Vogt Mach. Co., Henry, Louisville

Dust Collectors
Hardinge Co., York, Pa.

Dynamometers
Wheeler Mfg. Co., C. H., Phila.

Dynamos (See Generators)

Economizers
Green Fuel Economizer Co., Beacon, N. Y
Power Specialty Co., N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Ejectors
Chaplin-Fulton Mfg. Co., Pittsburgh
Penberthy Injector Co., Detroit

Ejectors, Air
Elliott Co., Jeannette, Pa.

Electric Generating Sets, Steam Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Elliott Co., Wellsville, N. Y.
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
General Electric Co., Schenectady
Moore Steam Turbine Corp., Wellsville, N. Y.
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford

Elevators and Conveyors
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Webster Mfg. Co., Chicago

Elevators, Factory
Ridgway & Fils Co., Craig, Coatesville, Pa.

Enamel
Nitrose Co., Peoria, Ill.
Wailes Dove-Hermiston Corp., N. Y.

Engine Repairs
Hooven, Owens, Rentschler Co., Hamilton, O.
Underwood Corp., H. B., Phila.

Engineering Service (See Directory)

Engines, Corliss
Allis-Chalmers Mfg. Co., Milwaukee
Chuse Engine & Mfg. Co., Mattoon, Ill.
Hooven, Owens, Rentschler Co., Hamilton, O.
Nordberg Mfg. Co., Milwaukee

Engines, Diesel
Busch, Sulzer Bros., Diesel Eng. Co., St. Louis
Fairbanks, Morse & Co., Chicago
Hooven, Owens, Rentschler Co., Hamilton, O.
Lombard Governor Co., Ashland, Mass.
Mianus Diesel Engine Corp., N. Y.
Nordberg Mfg. Co., Milwaukee
Worthington Pump & Machy. Corp., N. Y.

Engines, Gas and Oil
Allis-Chalmers Mfg. Co., Milwaukee
Busch, Sulzer Bros., Diesel Eng. Co., St. Louis
Chicago Pneumatic Tool Co., N. Y.
Fairbanks, Morse & Co., Chicago
Hooven, Owens, Rentschler Co., Hamilton, O.
Ingersoll-Rand Co., N. Y.
Mianus Diesel Engine Corp., N. Y.
Sterling Engine Co., Buffalo
Worthington Pump & Machy. Corp., N. Y.

Engines, Hoisting
Hooven, Owens, Rentschler Co., Hamilton, O.

Engines, Pumping
Hooven, Owens, Rentschler Co., Hamilton, O.

Engines, Steam
Air Preheater Co., N. Y.
Allis-Chalmers Mfg. Co., Milwaukee
Chicago Pneumatic Tool Co., N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clarage Fan Co., Kalamazoo, Mich.
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Erie City Iron Works, Erie, Pa.
Harrisburg (Pa.) Foundry & Machine Works
Hooven, Owens, Rentschler Co., Hamilton, O.
Nordberg Mfg. Co., Milwaukee
Ridgway (Pa.) Dynamo & Engine Co.
Skinner Engine Co., Erie, Pa.
Stanwood Corp., Cincinnati
Sturtevant Co., B. F., Hyde Park, Mass.
Troy (Pa.) Engine & Machine Co.

Engines, Steam Una-Flow
Chuse Engine & Mfg. Co., Mattoon, Ill.
Harrisburg (Pa.) Fdy. & Mch. Wks.
Kingsford Fdry. & Mach. Works, Oswego, N. Y.
Nordberg Mfg. Co., Milwaukee
Skinner Engine Co., Erie, Pa.

Evaporators
Griscom-Russell Co., N. Y
Ross Heater & Mfg. Co., Buffalo
Wheeler Condenser & Engineering Co., Carteret, N. J.

Exhaust Heads
Direct Separator Co., Syracuse, N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Sturtevant Co., B. F., Hyde Park, Mass.
Swartwout Co., Cleveland
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Exhausters, Gas
Sturtevant Co., B. F., Hyde Park, Mass.

Expansion Joints
Badger & Sons, Co., E. B., Boston
Griscom-Russell Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Wheeler Condenser & Engineering Co., Carteret, N. J.
Wheeler Mfg. Co., C. H., Phila.

Fans, Exhaust and Ventilator
(See Blowers, Fan)

Filters, Feed Water
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Hardinge Co., York, Pa.

Filters, Oil
Elliott Co., Jeannette, Pa.
Nugent & Co., Wm. W., Chicago

Filters, Oil System
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Filters, Oil Removal
Griscom-Russell Co., N. Y.
Permutit Co., N. Y.
Scaife & Sons Co., Wm. B., Pittsburgh

Filters, Pressure
Cochrane Corp., Phila.
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.

Filters, Water
Paige & Jones Chemical Co., Hammond, Ind.
Permutit Co., N. Y.
Scaife & Sons, Wm. B., Pittsburgh

Forgings, Monel Metal and Nickel
International Nickel Co., N. Y.

Firebox Blocks
Bernitz Furnace Appliance Co., Boston
McLeod & Henry Co., Troy, N. Y.
Walsh Fire Clay Products Co., St. Louis

Fire Extinguishers
Badger & Sons, Co., E. B., Boston

Fittings, Ammonia
Greene, Tweed & Co., N. Y.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Fittings, Pipe
American Spiral Pipe Works, Chicago

Flanges
American Spiral Pipe Works, Chicago
Dart Mfg. Co., E. M., Providence
Jefferson Union Co., Lexington, Mass.
Jenkins Bros., N. Y.
Power Piping Co., Pittsburgh
Vogt Machine Co., Henry, Louisville

Floats
Hercules Float Wks., Springfield, Mass.

Foundations, Machinery
Ballard, Sprague & Co., N. Y.

Fuel Oil Systems
Coen Co., San Francisco
Combustion Engr. Corp., N. Y.
Engineer Co., N. Y.
Morse Dry Dock & Repair Co., Brooklyn
National Airoil Burner Co., Phila.
Peabody Engr. Corp., N. Y.

Furnace Arches
Bernitz Furnace Appliance Co., Boston
Betson Plastic Fire Brick Co., Rome, N. Y.
Bigelow Arch Co., Detroit
Detrick Co., M. H., Chicago
Hofft Co., M. A., Indianapolis
Liptak Fire Brick Arch Co., Mexico, Mo.
McLeod & Henry Co., Troy, N. Y.
Queen's Run Refractories Co., Lock Haven, Pa.

Furnace Bottoms, Cast Iron Air Cooled
Allen, Sherman, Hoff Co., Phila.

Furnace Construction
Cement Gun Co., Allentown, Pa.
Plibrico Jointless Firebrick Co., Chicago

Furnace Linings
Betson Plastic Fire Brick Co., Rome, N. Y.
Botfield Refractories Co., Phila.
Cement Gun Co., Allentown, Pa.
General Refractories Co., Phila.
McLeod & Henry Co., Troy, N. Y.
Plibrico Jointless Firebrick Co., Chicago
Queen's Run Refractories Co., Lock Haven, Pa.
Walsh Fire Clay Products Co., St. Louis

Furnaces
Combustion Engineering Corp., N. Y.
Detroit Stoker Co., Detroit
Erie City Iron Wks., Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Hofft Co., M. A., Indianapolis
Illinois Stoker Co., Alton, Ill.
McClave-Brooks Co., Scranton, Pa.

Furnaces, Bagasse & Wood Burning
Combustion Engineering Corp., N. Y.
Detrick Co., M. H., Chicago
McClave-Brooks Co., Scranton, Pa.

Furnaces, Corrugated
American Spiral Pipe Works, Chicago

Furnaces, Incinerator
Combustion Engineering Corp., N. Y.
McClave-Brooks Co., Scranton, Pa.

Fuses
General Electric Co., Schenectady

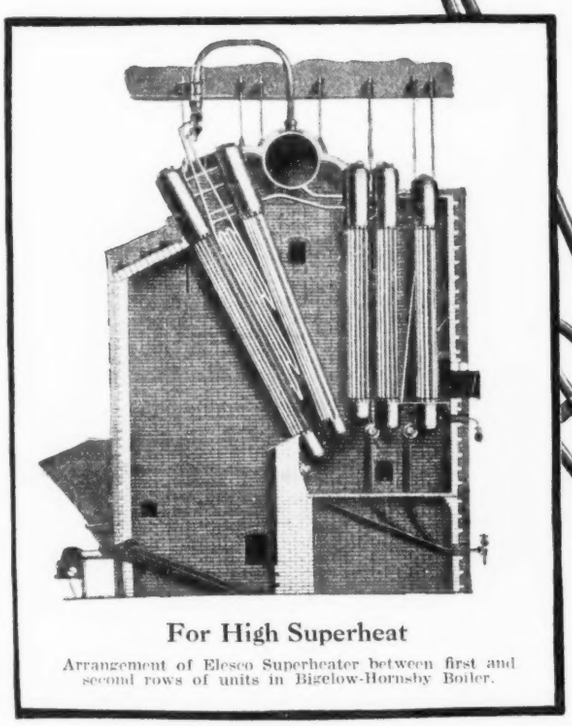
Gage Glass Guards & Shields
Huvette Co., Paul B., Phila.
Jenkins Bros, N. Y.

Gage Glasses
Chesterton Co., A. W., Boston
Jenkins Bros, N. Y.
Libbey Glass Mfg. Co., Toledo, Ohio

Gages, Differential
Bailey Meter Co., Cleveland

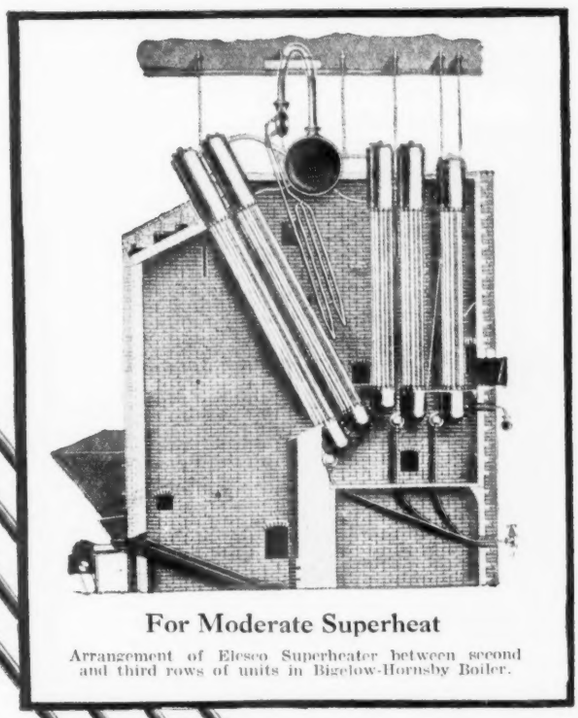
Gages, Draft
Bailey Meter Co., Cleveland

Putting the Superheater where it does the most good—



For High Superheat

Arrangement of Elesco Superheater between first and second rows of units in Bigelow-Hornsby Boiler.



For Moderate Superheat

Arrangement of Elesco Superheater between second and third rows of units in Bigelow-Hornsby Boiler.

The design of an Elesco Superheater is so flexible as to permit its location in the most advantageous temperature zone for the superheat specified. The above illustrations show two different locations within the same type of boiler.

For moderate temperatures the superheater units are located in the free space between the second and third rows of boiler units.

While for higher superheats the units are placed between the first and second rows of units; these two rows being spread so as to provide a triangular space for the superheater. High superheat is obtained with a relatively small heating surface, minimum draft loss and low pressure drop. The superheater being located in that part of the boiler which evaporates most of the steam, the superheater will give the most uniform results at all ratings, as it is affected by the same factors as is the boiler.

Elesco Advisory Engineers, as well as our literature, are at your disposal.

THE SUPERHEATER COMPANY

17 East 42nd Street
NEW YORK

ELESCO

Peoples Gas Building
CHICAGO

Boston Pittsburgh

Canada: The Superheater Company, Limited, Montreal

Bristol Co., Waterbury, Conn.
Peabody Engr. Corp., N. Y.
Taylor Instr. Co.'s, Rochester

Gages, Pressure
American Schaeffer & Budenberg Corp., Brooklyn
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Phila.
Crosby Steam Gage & Valve Co., Boston
Taylor Instr. Co.'s, Rochester

Gages, Recording
American Schaeffer & Budenberg Corp., Brooklyn
Brown Instrument Co., Phila.
Crosby Steam Gage & Valve Co., Boston

Gages, Vacuum
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Phila.
Crosby Steam Gage & Valve Co., Boston
Greene, Tweed & Co., N. Y.

Gages, Water
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Williams Gauge Co., Pittsburgh

Gas Burning Equipment
Mettler Co., Lee B., Los Angeles, Cal.

Gas Exhausters
General Electric Co., Schenectady

Gaskets
Advance Packing & Supply Co., Chicago
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Smooth On Mfg. Co., Jersey City N. J.
U. S. Rubber Co., N. Y.

Gates, Coal & Ash Bin
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Brown Hoisting Machinery Co., Cleveland
Conveyors Corp. of America Chicago
Gifford-Wood Co., Hudson, N. Y.
Hunt Co., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Republic Flow Meters Co., Chicago
Webster Mfg. Co., Chicago

Gears
Earle Gear & Mach. Co., Phila.
Foote Bros. Gear & Mach. Co., Chicago
Ganschow Co., Wm., Chicago
General Electric Co., Schenectady
James Mfg. Co., D. O., Chicago
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
Republic Flow Meters Co., Chicago
Philadelphia (Pa.) Gear Works
Webster Mfg. Co., Chicago

Gears, Double Helical
De Laval Steam Turbine Co., Trenton, N. J.

Gears, Reduction
De Laval Steam Turbine Co., Trenton, N. J.
Elliott Co., Wellsville, N. Y.
Foote Bros. Gear & Mach. Co., Chicago
Ganschow Co., Wm., Chicago
James Mfg. Co., D. O., Chicago
Moore Steam Turbine Corp., Wellsville, N. Y.
Philadelphia (Pa.) Gear Works

Generating Sets
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Fairbanks, Morse & Co., Chicago
General Electric Co., Schenectady
Ridgway (Pa.) Dynamo & Engine Co.
Sturtevant Co., B. F., Hyde Park, Mass.

Generators, Electric
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Fairbanks, Morse & Co., Chicago
General Electric Co., Schenectady
Sturtevant Co., B. F., Hyde Park, Mass.

Governors, Engine
Gardner-Governor Co., Quincy, Ill.
Pickering Governor Co., Portland, Conn.

Governors, Pressure
Northern Equipment Co., Erie, Pa.

Governors, Pump
Chanlin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Fisher Governor Co., The, Marshalltown, Iowa
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Walworth Co., Boston
Williams Gauge Co., Pittsburgh
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Governors, Water-Wheel
Lombard Governor Co., Ashland, Mass.

Governors, Turbine
Pickering Governor Co., Portland, Conn.

Graphite
Greene, Tweed & Co., N. Y.

Grate Bars and Clips
Bethlehem (Pa.) Shipuilding Corp.
Riley Stoker Corp., Worcester

Grates
Babcock & Wilcox Co., N. Y.
CoKal Stoker Corp., Chicago
Combustion Engr. Corp., N. Y.
Cyclone Grate Bar Co., Buffalo
Delany & Co., P. Newburgh, N. Y.
Erie City Iron Wks., Erie, Pa.
Flynn & Emrich Co., Baltimore
Kelly Foundry & Mach. Co., Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Marion Machine Fdry. & Supply Co., Marion, Ind.
Neemes Foundry, Inc., Troy, N. Y.
Riley Stoker Corp., Worcester
Vogt Mach. Co., Henry, Louisville

Grates, Round
McClave-Brooks Co., Scranton, Pa.

Grease
Keystone Lubricating Co., Phila.
Waverly Oil Wks. Co., Pittsburgh

Grease Extractors
Elliott Co., Jeannette, Pa.

Grinders, Air & Elec., Portable
Chicago Pneumatic Tool Co., N. Y.

Hammers, Pneumatic
Chicago Pneumatic Tool Co., N. Y.
Ingersoll Rand Co., N. Y.

Heaters, Air
Air Preheater Co., N. Y.
Combustion Engineering Corp., N. Y.
Prat-Daniel Corp., N. Y.

Heaters, Deaerating
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.

Heaters, Domestic
Ross Heater & Mfg. Co., Buffalo

Heaters, Feed Water
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Erie City Iron Wks., Erie, Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Patterson-Kelley Co., N. Y.
Permutit Co., N. Y.
Ross Heater & Mfg. Co., Buffalo
Schutte & Koerting Co., Phila.
Swartwout Co., Cleveland
Wheeler Condenser & Engineering Co., Carteret, N. J.
Worthington Pump & Machy. Corp., N. Y.

Heaters, Hot Water Service
Patterson-Kelley Co., N. Y.

Heaters, Metering
Cochrane Corp., Phila.

Heaters, Oil
Coen Co., San Francisco
Griscom-Russell Co., N. Y.
Power Specialty Co., N. Y.

Heaters, Steam Stack
Cochrane Corp., Phila.

Heaters, Storage
Cochrane Corp., Phila.

Heating and Ventilating Systems
Buffalo Forge Co., Buffalo
Clarage Fan Co., Kalamazoo, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
Woodwell, J. E., N. Y.

Hoists, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio

Hoists, Electric
Beaumont Co., R. H., Phila.

Hoists, Portable
Sullivan Machinery Co., Chicago

Hoists, Steam
Sullivan Machinery Co., Chicago

Hoppers, Coal and Ash
Allen, Sherman, Hoff Co., Phila.
Beaumont Co., R. H., Phila.
Combustion Engineering Corp., N. Y.
Conveyors Corp. of Amer., Chicago
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Republic Flow Meters Co., Chicago
Webster Mfg. Co., Chicago

Hose, Air
Chicago Pneumatic Tool Co., N. Y.
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Rubber
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Hose, Steam
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Tube Cleaner
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Hose, Water
Lagonda Mfg. Co., Springfield, Ohio
Liberty Mfg. Co., Pittsburgh

Ice Machine Repairs
Underwood Corp., H. B., Phila.

Ice and Refrigerating Machinery
(See Refrigerating Machinery)

Indicators, Load
Cutler-Hammer Mfg. Co., Milwaukee

Indicators, Speed
Biddle, James G., Phila.
Zernickow, Co., O., N. Y.

Indicators, Steam Engine
Crosby Steam Gage & Valve Co., Boston

Indicators, Valve Position
Cutler-Hammer Mfg. Co., Milwaukee
Northern Equipment Co., Erie, Pa.

Injectors
Jenkins Bros., N. Y.
Penberthy Injector Co., Detroit
Schutte & Koerting Co., Phila.

Intercoolers
Griscom-Russell Co., N. Y.

Lamps, Arc
General Electric Co., Schenectady

Lamps, Incandescent
General Electric Co., Schenectady

Lubricants
Keystone Lubricating Co., Phila.
Waverly Oil Wks. Co., Pittsburgh

Lubricators, Cylinder
Bowser & Co., S. F., Fort Wayne, Ind.

Lubricators, Force Feed
Bowser & Co., S. F., Fort Wayne, Ind.
Empire Refineries, Inc., Tulsa, Okla.
Greene, Tweed & Co., N. Y.
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Machine Screws, Monel Metal
International Nickel Co., N. Y.

Meters, Air
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady

Meters, Boiler
Bailey Meter Co., Cleveland

Meters, Coal
Bailey Meter Co., Cleveland

Meters, Electric
General Electric Co., Schenectady

Meters, Feed Water
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Flow
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Gas
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady

Meters, Oil
Cochrane Corp., Phila.
General Electric Co., Schenectady
Worthington Pump & Machy. Corp., N. Y.

Meters, Steam
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
General Electric Co., Schenectady

Meters V-Notch
Bailey Meter Co., Cleveland
Cochrane Corp., Phila.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Volumetric
Cochrane Corp., Phila.

Meters, Water
Cochrane Corp., Phila.
General Electric Co., Schenectady
Hoppes Mfg. Co., Springfield, Ohio
Worthington Pump & Machy. Corp., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila.

Meters, Weighing
Cochrane Corp., Phila.

Monel Metal Sheets, Rods, Castings
International Nickel Co., N. Y.

Motors, Electric
Allis-Chalmers Mfg. Co., Milwaukee
Engberg's Electric & Mechanical Wks., St. Joseph, Mich.
Fairbanks, Morse & Co., Chicago
General Electric Co., Schenectady
Lincoln Electric Co., Cleveland

Motors, Water
Roto Co., Hartford, Conn.

Nickel Sheets, Rods, Castings
International Nickel Co., N. Y.

Oil and Grease Cups
Keystone Lubricating Co., Phila.
Lunkenheimer Co., Cincinnati
Penberthy Injector Co., Detroit
Powell Co., Wm., Cincinnati

Oil, Lubricating
Keystone Lubricating Co., Phila.
Waverly Oil Wks. Co., Pittsburgh

Oil Purifiers, Centrifugal
De Laval Steam Turbine Co., Trenton, N. J.

Oil Reclaimers
Bowser & Co. S. F., Fort Wayne, Ind.
DeLaval Separator Co., N. Y.

Oil Reservoirs
Coatesville (Pa.) Boiler Works

Oilers, Sight Feed and Multiple
Bowser & Co., S. F., Fort Wayne, Ind.
Lunkenheimer Co., Cincinnati
Nugent & Co., Wm. W., Chicago

Oilers, Telescopic and Centrifugal
Bowser & Co., S. F., Fort Wayne Ind.
Nugent & Co., Wm. W., Chicago

Oiling Devices and Systems
Bowser & Co., S. F., Fort Wayne, Ind.
Nugent & Co., Wm. W., Chicago

Packing, Asbestos
Advance Packing & Supply Co., Chicago
Garlock Packing Co., Palmyra, N. Y.
Keasbey & Mattison Co., Ambler, Pa.

Packing, Condenser Tube
Crane Packing Co., Chicago

Packing, Cylinder
Chesterton Co., A. W., Boston

Packing, Flax
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.

Packing, Hydraulic
Crane Packing Co., Chicago
Chesterton Co., A. W., Boston
Garlock Packing Co., Palmyra, N. Y.

Packing, Metallic
Crane Packing Co., Chicago
Garlock Packing Co., Palmyra, N. Y.

Packing Metallic Flexible
Garlock Packing Co., Palmyra, N. Y.

Packing, Piston
Chesterton Co., A. W., Boston
Crane Packing Co., Chicago
Garlock Packing Co., Palmyra, N. Y.
U. S. Rubber Co., N. Y.

Packing Pump Valve
Garlock Packing Co., Palmyra, N. Y.

Packing, Rod
Chesterton Co., A. W., Boston
Crane Packing Co., Chicago
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Packing, Sheet
Advance Packing & Supply Co., Chicago
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., N. Y.
Jenkins Bros., N. Y.
Keasbey & Mattison Co., Ambler, Pa.
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.
U. S. Rubber Co., N. Y.

Packing, Valve Stem
Crane Packing Co., Chicago
Garlock Packing Co., Palmyra, N. Y.

Paints, Heat Resisting
Nitrose Co., Peoria, Ill.

Paints, Industrial
Nitrose Co., Peoria, Ill.
Wailes Dove-Hermiston Corp., N. Y.

Pinions, Rawhide
James Mfg. Co., D. O., Chicago

Pipe
American Spiral Pipe Works, Chicago
Byers Co., A. M., Pittsburgh
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co., St. Louis
Power Piping Co., 681 Beaver Ave., N. S., Pittsburgh

Pipe Bending
Kellogg Co., M. W., N. Y.
National Valve & Mfg. Co., Pittsburgh
Power Piping Co., Pittsburgh

Pipe Coils
Abendroth & Root Mfg. Co., N. Y.
Grinnell Co., Providence, R. I.

Pipe Cutting and Threading Machines
Curtis & Curtis Co., Bridgeport
Toledo (Ohio) Pipe Threading Mach. Co.

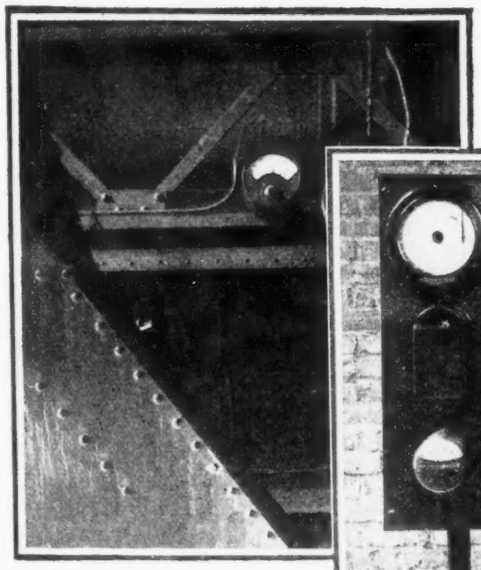
Pipe Fittings
American Spiral Pipe Works, Chicago
Jefferson Union Co., Lexington, Mass.
Kellogg Co., M. W., N. Y.
Power Piping Co., Pittsburgh

Pipe, Forge Welded
American Spiral Pipe Works, Chicago

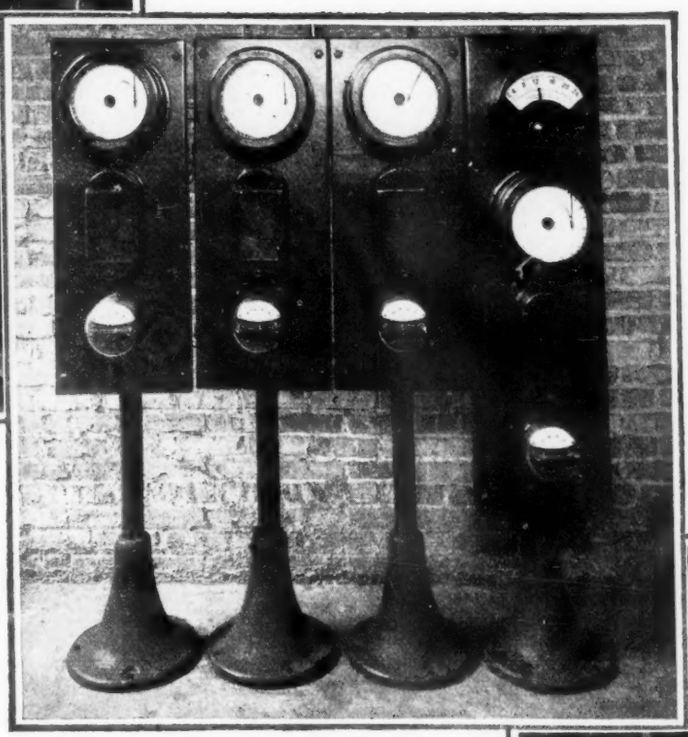
Pipe, Pressure
American Spiral Pipe Works, Chicago

Pipe Spiral, Riveted
Abendroth & Root Mfg. Co., N. Y.
American Spiral Pipe Works, Chicago

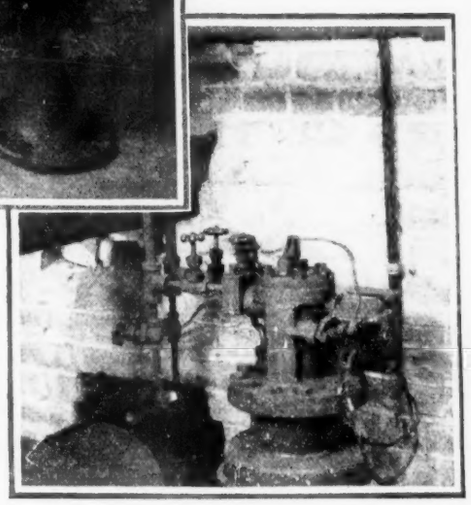
Pipe, Welded and Seamless
American Spiral Pipe Works, Chicago
Kellogg Co., M. W., N. Y.



Indicating Flow Meter on boiler



Curve-drawing and Integrating Flow Meters located where convenient



Flow Meter Body at pipe line

Maintaining economy in the production of gas and electricity

Five G-E Flow Meters in the large electric station of the Western United Corporation at Aurora, Illinois, measure both feed water and steam; three in the Coal Products Manufacturing Company at Joliet, Illinois, verify the economy of process steam.

The benefits of G-E Flow Meters to public utilities extend far beyond their walls, for the attainment of economy, by the regulation of costs, is evidenced in the rates for electricity and gas.

Thus G-E Flow Meters not only simplify management, but serve to enhance that invaluable asset, good will. Ask a district G-E flow meter specialist to give you information about them.

Flow Meters

MECHANICALLY OPERATED
ELECTRICALLY OPERATED

The flexibility of the electrically operated meter permits the instruments to be located where desired. The mechanically operated meter concentrates all instruments under one cover. Whichever meter best suits your needs, G-E can supply it.

37-19

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN ALL PRINCIPAL CITIES

Piping Contractors
Kellogg Co., M. W., N. Y
Midwest Piping & Supply Co., St. Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Piping, Fabricators
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co., St. Louis

Piping, High Pressure
American Spiral Pipe Works, Chicago
Byers Co., A. M., Pittsburgh
Kellogg Co., M. W., N. Y.
Midwest Piping & Supply Co. St. Louis
National Valve & Mfg. Co., Pittsburgh
Pittsburgh (Pa.) Valve Fdry. & Constr. Co.
Power Piping Co., Pittsburgh

Piping, Wrought Iron
Byers Co., A. M., Pittsburgh

Pneumatic Tools
Ingersoll Rand Co., N. Y.

Power Transmission Machinery
Allis-Chalmers Mfg. Co., Milwaukee
Foote Bros. Gear & Mach. Co., Chicago
[illegible] Mfg. Co., Columbus, O.
Link-Belt Co., Chicago
[illegible] Co., Rome, N. Y.
Webster Mfg. Co., Chicago

Pre-Heaters, Air
Air Preheater Co., N. Y.
Buffalo Forge Co., Buffalo
Combustion Engineering Corp., N. Y.
Prat-Daniel Corp., N. Y.

Preheaters & Heat Exchanges, Water
Patterson-Kelley Co., N. Y.

Pulleys
Greene, Tweed & Co., N. Y.
Link-Belt Co., Chicago

Pulleys, Magnetic
Magnetic Mfg. Co., Milwaukee

Pulverized Coal Equipment
Combustion Engr. Corp., N. Y.
Erie City Iron Works, Erie, Pa.
Fuller-Lehigh Co., Fullerton, Pa.
Hardinge Co., York, Pa.
Jeffrey Mfg. Co., Columbus, O.

Pump Liners, Monel Metal
International Nickel Co., N. Y.

Pump Rods, Monel Metal
International Nickel Co., N. Y.

Pumps, Air
Elliott Co., Jeannette, Pa.
Fairbanks, Morse & Co., Chicago
Wheeler Mfg. Co., C. H., Phila.

Pumps, Boiler Feed
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo Steam Pump Co., Buffalo
Coppus Engineering Corp., Worcester, Mass.
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Earle Gear & Machine Co., Phila.
Erie Pump & Engine Wks., Medina, N. Y.
Fairbanks, Morse & Co., Chicago
Gardner Governor Co., Quincy, Ill.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Lecourtenay Co., Newark, N. J.
Moore Steam Turbine Corp., Wellsville, N. Y.
Platt Iron Wks., Dayton, Ohio
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo Steam Pump Co., Buffalo
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Earle Gear & Machine Co., Phila.
Erie Pump & Engine Works, Medina, N. Y.
Fairbanks, Morse & Co., Chicago
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Lecourtenay Co., Newark, N. J.
Manistee (Mich.) Iron Works Co.
Moore Steam Turbine Corp., Wellsville, N. Y.
Taber Pump Co., Buffalo
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Condenser
Elliott Co., Jeannette, Pa.
Fairbanks, Morse & Co., Chicago
Wheeler Mfg. Co., C. H., Phila.

Pumps, Deep Well
Fairbanks, Morse & Co., Chicago
Pumps, Force Feed (See Lubricators)

Pumps, Fuel Oil Service
Dean Bros. Co., Indianapolis
Fairbanks, Morse & Co., Chicago
Warren (Mass.) Steam Pump Co.

Pumps, Mine
Allis-Chalmers Mfg. Co., Milwaukee
Fairbanks, Morse & Co., Chicago
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y

Pumps, Oil
Bowser & Co., S. F., Fort Wayne, Ind.
Coen Co., San Francisco
Dean Bros. Co., Indianapolis
Fairbanks, Morse & Co., Chicago
Gardner-Governor Co., Quincy, Ill.
Nugent & Co., Wm. W., Chicago

Pumps, Power
Aldrich Pump Co., Allentown, Pa.
Dean Bros. Co., Indianapolis
Fairbanks, Morse & Co., Chicago
Gardner Governor Co., Quincy, Ill.
Platt Iron Works, Dayton, Ohio
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Rotary
Taber Pump Co., Buffalo
Wheeler Mfg. Co., C. H., Phila.

Pumps, Screw
Fairbanks, Morse & Co., Chicago

Pumps, Steam
Aldrich Pump Co., Allentown, Pa.
Dean Bros. Co., Indianapolis
Dean Hill Pump Co., Anderson, Ind.
Fairbanks, Morse & Co., Chicago
Gardner Governor Co., Quincy, Ill.
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Manistee (Mich.) Iron Works Co.
Warren (Mass.) Steam Pump Co.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Sump
Fairbanks, Morse & Co., Chicago

Pumps, Turbine
Allis-Chalmers Mfg. Co., Milwaukee
Dean Hill Pump Co., Anderson, Ind.
Elliott Co., Wellsville, N. Y.
Fairbanks, Morse & Co., Chicago
Ingersoll-Rand Co. (A. S. Cameron Steam Pump Works) N. Y.
Moore Steam Turbine Corp., Wellsville, N. Y.
Terry Steam Turbine Co., Hartford

Pumps, Vacuum
Elliott Co., Jeannette, Pa.
Fairbanks, Morse & Co., Chicago
Ingersoll-Rand Co., N. Y.
Sullivan Machinery Co., Chicago
Warren (Mass.) Steam Pump Co.
Wheeler Mfg. Co., C. H., Phila.
Worthington Pump & Machy. Corp., N. Y.

Pumps, Water-Works
Allis-Chalmers Mfg. Co., Milwaukee
Buffalo Steam Pump Co., Buffalo
Fairbanks, Morse & Co., Chicago
Worthington Pump & Machy. Corp., N. Y.

Purifiers, Feed Water
Cochrane Corp., Phila., Pa.
Griscom-Russell Co., N. Y.
Hoppes Mfg. Co., Springfield, Ohio
Permutit Co., N. Y.
Yarnall-Waring Co., Mermaid Ave., Phila., Pa.

Purifiers, Oil
Bowser & Co., S. F., Fort Wayne, Ind.
DeLaval Separator Co., N. Y.

Purifiers, Steam
Andrews-Bradshaw Co., Pittsburgh
Cochrane Corp., Phila.

Pyrometers
Bristol Co., Waterbury
Brown Instrument Co., Phila.
Leeds & Northrup Co., Phila.
Taylor Instr. Co.'s, Rochester

Recorders, Vacuum
Bacharach Industrial Inst. Co., Pittsburgh
Crosby Steam Gage & Valve Co., Boston

Refrigerating Machinery
Ingersoll Rand Co., N. Y.
Vogt Machine Co., Henry, Louisville
York Mfg. Co., York, Pa.

Regulators, Blower
McClave-Brooks Co., Scranton, Pa.

Regulators, Damper, Draft and Fan
Hagan Corp., Pittsburgh
Smidth Co., F. L., N. Y.
Smoot Engr. Corp., N. Y.
Walworth Co., Boston

Regulators, Feed Water
Fulton Co., Knoxville, Tenn.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Smidth Co., F. L., N. Y.
Squires Co., C. E., Cleveland
Walworth Co., Boston
Williams Gauge Co., Pittsburgh

Regulators, Gas
Davis Regulator Co., G. M., Chicago

Regulators, Pressure
Atlas Valve Co., Newark, N. J.
Carrick Engineering Co., Chicago
Chaplin-Fulton Mfg. Co., Pittsburgh
Davis Regulator Co., G. M., Chicago
Engineer Co., N. Y.
Fisher Governor Co., The, Marshalltown, Iowa
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland
Walworth Co., Boston

Regulators, Pump
Edward Valve & Mfg. Co., E Chicago, Ind.
Mason Regulator Co., Boston
Northern Equipment Co., Erie, Pa.
Squires Co., C. E., Cleveland

Regulators, Temperature
Sarco Co., N. Y.
Taylor Instrument Co.'s, Rochester

Reservoirs, Oil
Bowser & Co., S. F., Fort Wayne, Ind.
Coatesville (Pa.) Boiler Works

Rheostats
General Electric Co., Schenectady

Rings, Monel Metal
International Nickel Co., N. Y.

Rivets
Champion Rivet Co., Cleveland

Rods, Monel Metal and Nickel
International Nickel Co., N. Y.

Rope Transmission
American Steel & Wire Co., Chicago
Hunt Co., C. W., West New Brighton, N. Y.

Rubber Goods
N. Y. Belting & Packing Co., N. Y.
Quaker City Rubber Co., Wissinoming, Phila.

Scale Removers
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh
Pierce Co., Wm. B., Buffalo
Roto Co., Hartford, Conn.

Screens, Shaking & Revolving
Gifford-Wood Co., Hudson, N. Y.

Screens, Water Intake
Link-Belt Co., Chicago

Second-Hand Equipment (See Searchlight Section)
Allis-Chalmers Mfg. Co.
Brownell Engr. Co., G. W.
Davis, J. F.
Industrial Plants Corp.
Nashville Industrial Corp.
O'Brien Mchy. Co.
Oklahoma High Line Constr. Co.
Ross Power Equipment Co.
Sachsenmaier, Geo.
Scheinert Co., R.
West End Mfg. Co.

Separators, Air
Cochrane Corp., Phila.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.

Separators, Ammonia
Cochrane Corp., Phila.
Elliott Co., Jeannette, Pa.
Gifford-Wood Co., Hudson, N. Y.

Separators, Oil
Cochrane Corp., Phila.
DeLaval Separator Co., N. Y.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Swartwout Co., Cleveland
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Separators, Magnetic
Magnetic Mfg. Co., Milwaukee
Separators, Receiver
Cochrane Corp., Phila.

Separators, Steam
Andrews-Bradshaw Co., Pittsburgh
Cochrane Corp., Phila.
Direct Separator Co., Syracuse, N. Y.
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Swartwout Co., Cleveland
Wright-Austin Co., 321 W. Woodbridge St., Detroit

Sheets, Monel Metal and Nickel
International Nickel Co., N. Y.

Signal Systems
Cutler-Hammer Mfg. Co., Milwaukee

Skimmers, Boiler
Yarnall-Waring Co., Mermaid Ave., Phila.
Speed Reducers
De Laval Steam Turbine Co., Trenton, N. J.
Foote Bros. Gear & Mach. Co., Chicago
Philadelphia (Pa.) Gear Works

Spray Nozzles
(See Cooling Plants and Ponds)

Stacks, Brick
Custodis Chimney Constr. Co., Alphons, N. Y.
Kellogg Co., M. W., N. Y.
Rust Engineering Co., Pittsburgh
Stacks, Concrete
Rust Engineering Co., Pittsburgh

Stacks, Metal
Connery & Co., Phila.
Erie City Iron Wks., Erie, Pa.
Heine Boiler Co., St. Louis
Kidwell Boiler Co., Milwaukee
Prat-Daniel Corp., N. Y.
Smith & Son Co., S., Paterson, N. J.
Union Iron Wks., Erie, Pa.
Walsh & Weidner Boiler Co., Chattanooga

Stacks, Radial Brick
American Chimney Corp., N. Y.
Ballard, Sprague & Co., N. Y.
Custodus Chimney Constr. Co., Alphons, N. Y.
Kellogg Co., M. W., N. Y.

Steel Plate Work
Heine Boiler Co., St. Louis
Union Iron Wks., Erie, Pa.

Stokers, Chain and Traveling Grate
Babcock & Wilcox Co., N. Y.
Combustion Engineer. Corp., N. Y.
Illinois Stoker Co., Alton, Ill.
Laclede Stoker Co., St. Louis, Mo
McClave-Brooks Co., Scranton, Pa
Riley Stoker Corp., Worcester
Rosedale Fdry. & Mach. Co., Pittsburgh
United Stokers Co., La Porte, Ind.

Stokers, Forced Draft
American Engineering Co., Phila.
Combustion Engineering Corp.
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.
United Stoker Co., Chicago

Stokers, Hand Operated
CoKal Stoker Corp., Chicago
Combustion Engineering Corp., N. Y
Flynn & Emrich Co., Baltimore
Gibby Engineering Co., E. Boston
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester
Hofft Co., M. A., Indianapolis
Marion Mch. Fdry. & Supply Co., Marion, Ind.

Stokers, Hopper Fed
Flynn & Emrich Co., Baltimore
Stokers, Hopper Feed Hand Operated
McClave-Brooks Co., Scranton, Pa.

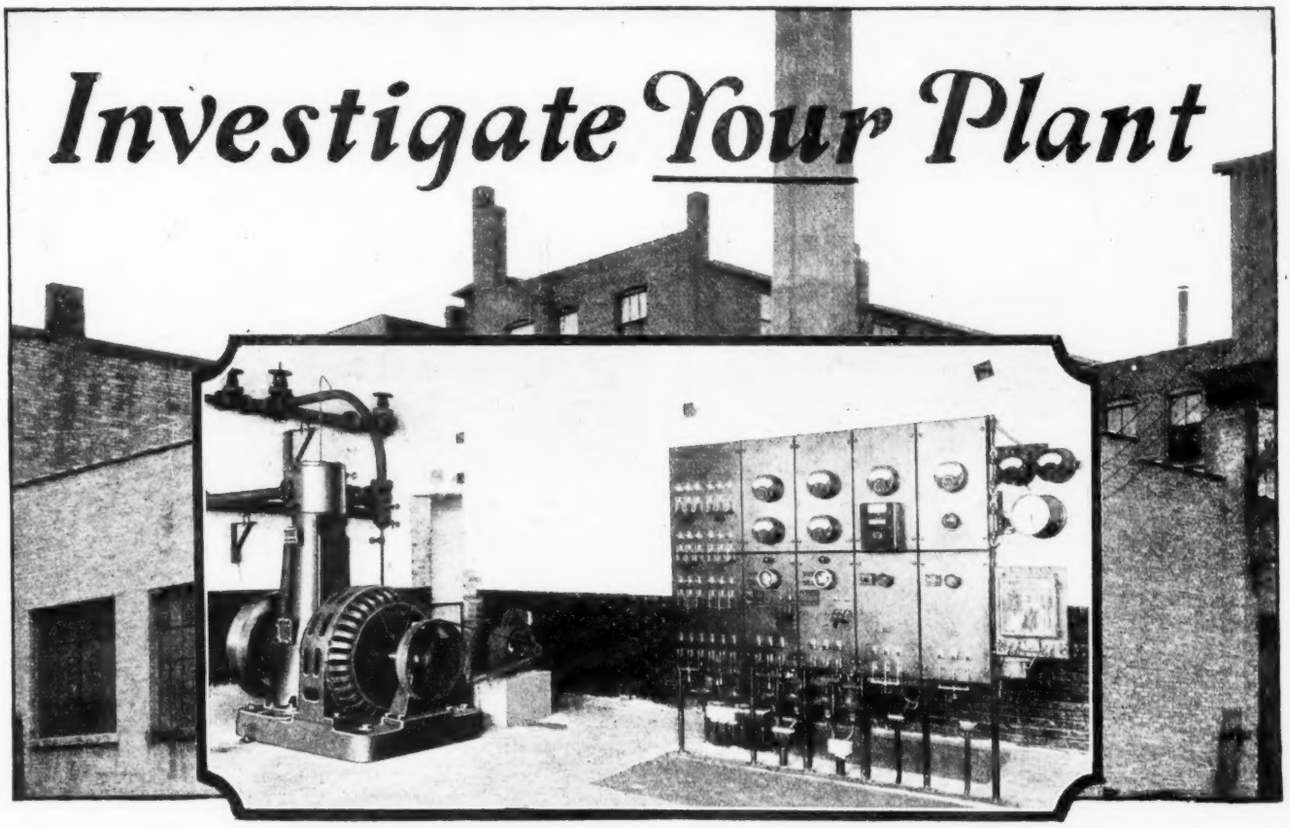
Stokers, Mechanical
American Engineering Co., Phila.
Babcock & Wilcox Co., N. Y.
Combustion Engineering Corp.
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
Illinois Stoker Co., Chicago
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.
United Stoker Co., Chicago

Stokers, Overfeed, Front Inclined and "V" Types
Detroit Stoker Co., Detroit
Flynn & Emrich Co., Baltimore
McClave-Brooks Co., Scranton, Pa.
Riley Stoker Corp., Worcester, Mass.

Stokers, Underfeed, Multiple Retort
American Engineering Co., Phila.
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Riley Stoker Corp., Worcester

Stokers, Underfeed, Single Retort
Combustion Engr. Corp., N. Y.
Detroit Stoker Co., Detroit
Riley Stoker Corp., Worcester
Sturtevant Co., B. F., Hyde Park, Mass.

Strainers, Oil
Bowser & Co., S. F., Ft. Wayne, Ind.
Coen Co., San Francisco
Elliott Co., Jeannette, Pa.
Griscom-Russell Co., N. Y.
Sarco Co., N. Y.



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You can make your own power and light requirements a real dividend paying asset instead of a liability and expense, if you will but investigate the installation of ENGBERG Generating Sets.

Such an investigation was made by Cahill and Douglas, Consulting Engineers of Milwaukee, for the Hotel Whitcomb Company, with the result that two ENGBERG 62½ K. V. A. Alternating Current Generating Sets were installed. These machines operate singly or in parallel, so that one unit can be utilized for the small loads and both units for the larger and peak loads with excellent economy.

That this installation was based on good sound judgment by engineers and owners is very clearly shown by the actual operating results—and this is but one of hundreds of similar plants in which ENGBERG generating sets are giving dependable and continuous service with equal or greater saving.

Write now and give us your requirements. You will receive a recommendation based on good sound engineering and business principles. Catalogs on request, No. 105 Direct Current Generating Sets and No. 800 Alternating Current Generating Sets.

ENGBERG'S ELECTRIC & MECHANICAL WORKS

143 Vine Street, St. Joseph, Michigan, U. S. A.

ENGBERG

Engberg THE STANDARD FOR EFFICIENCY-DURABILITY-SERVICE

Vertical, Enclosed Self-Oiling, Steam

ENGINES & GENERATING SETS

GENERATORS MOTORS SWITCHBOARDS

Strainers, Pump Suction
Elliott Co., Jeannette, Pa.

Strainers, Water
Elliott Co., Jeannette, Pa.
Rosedale Fdry. & Mach. Co., Pittsburgh, Pa.
Sarco Co., N. Y.

Superheaters
Babcock & Wilcox Co., N. Y.
Heine Boiler Co., St. Louis
Power Specialty Co., N. Y.
Superheater Co., N. Y.

Switchboards
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Biddle, James G., Phila.
Brown Instrument Co., Phila.
Foxboro Co., Inc., The, Foxboro, Mass.
Zernickow Co., O., N. Y.

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Taylor Instrument Co.'s, Rochester

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Bailey Meter Co., Cleveland
Leeds & Northrup Co., Phila.

Thermometers, Recording
Bailey Meter Co., Cleveland
Sarco Co., N. Y.
Taylor Instrument Co.'s, Rochester

Tramways, Aerial
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General Electric Co., Schenectady

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Ganschow Co., Wm., Chicago

Transmission Machinery
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Traps, Compressed Air
Armstrong Mach. Wks., Three Rivers, Mich.
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Templeton Mfg. Co., Boston

Traps, Grease
Armstrong Mach. Wks., Three Rivers, Mich.

Traps, Non-Return
Armstrong Mach. Wks., Three Rivers, Mich.
Sarco Co., N. Y.
Sterling Engr. & Mfg. Corp., Boston
Templeton Mfg. Co., Boston

Traps, Radiator
Amer. Schaeffer & Budenberg Corp., Brooklyn
Jenkins Bros., N. Y.
Morehead Mfg. Co., Detroit
Sarco Co., N. Y.
Schutte & Koerting Co., Phila.
Squires Co., C. E., Cleveland
Swartwout Co., Cleveland
Watson & McDaniel Co., Phila.

Traps, Return
Bundy Steam Trap Co., Nashua, N. H.
Ellis Drier Co., Chicago
Morehead Mfg. Co., Detroit
Sterling Engr. & Mfg. Co., Boston
Templeton Mfg. Co., Boston

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Ellis Drier Co., Chicago
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Patterson-Kelley Co., N. Y.
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Wright-Austin Co., 321 W. Woodbridge St., Detroit
Yarnall-Waring Co., Mermaid Ave., Phila.

Traps, Superheated Steam
Armstrong Mach. Wks., Three Rivers, Mich.
Nicholson & Co., W. H., Wilkes-Barre, Pa.

Traps, Vacuum
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Tube Cleaners, Boiler
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Liberty Mfg. Co., Pittsburgh
Pierce Co., Wm. B., Buffalo
Rosedale Fdry. & Mach. Co., Pittsburgh
Roto Co., Hartford, Conn.

Tube Cleaners Condenser
Lagonda Mfg. Co., Springfield, Ohio
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Tube Cutters
Lagonda Mfg. Co., Springfield, Ohio

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Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Boiler, Charcoal Iron
Tyler Tube & Pipe Co., Washington, Pa.

Tubes, Boiler, Lap Welded
Tyler Tube & Pipe Co., Washington, Pa.

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Dean Hill Pump Co., Anderson, Ind.
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Moore Steam Turbine Corp., Wellsville, N. Y.
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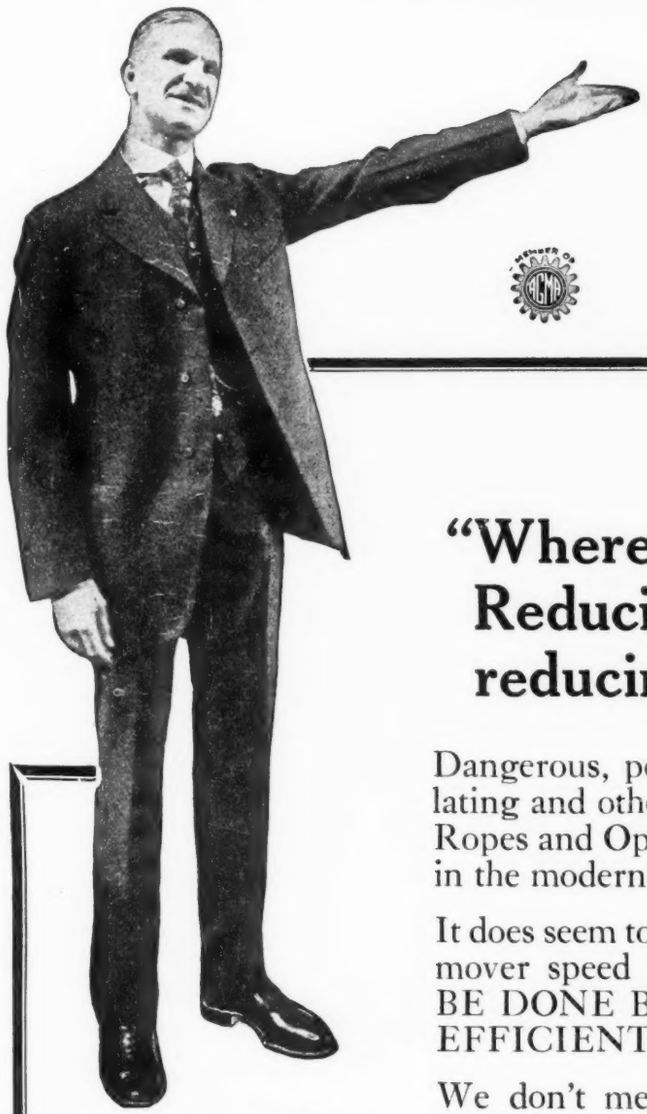

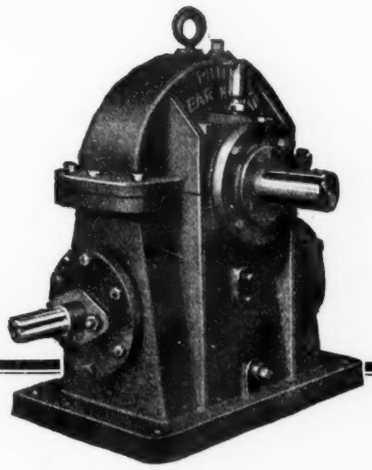

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